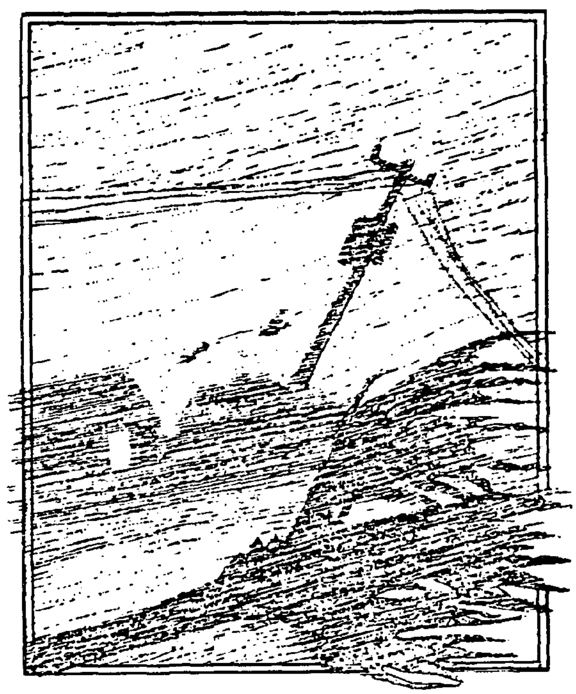
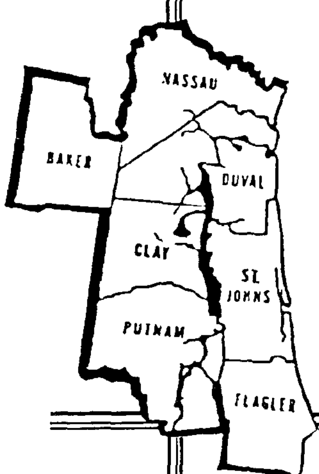
NORTHEAST FLORIDA HURRICANE EVACUATION STUDY - PHASE I





Northeast Florida
Regional Planning Council

1984

NORTHEAST FLORIDA
HURRICANE EVACUATION STUDY

PHASE I

February 1984

Prepared by the
Northeast Florida Regional Planning Council
8641 Baypine Road, Suite 9
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ACKNOWLEDGEMENTS

Research and planning in the area of public safety can be accomplished only with the cooperation of individuals, both in government and in the community. I would first like to thank all the members of the Northeast Florida Hurricane Evacuation Study Technical Adsivory Committee, many of whom made substantial input, and reviewed and critiqued the Study as it was being developed. They are listed as follow:

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Florida Department of Health
and Rehabilitative Services

This was a grass roots study effort inasmuch as many people in addition to those listed in the foregoing made input for which I am grateful. In St. Johns County, a special committee was formed to inspect public schools as potential sheltering facilities. The members included Messrs. Steve Hand, Wally Baughn, John Atkins, and Douglas Steward of the St. Johns County School Board; Mr. Gary Rodehorst, Civil Defense Director; and Mr. Bill Tyler, Mrs. Stuart Crouch, and Mrs. Irene Pace of the American Red Cross. They were assisted by Mrs. Jane Cassell, a consultant under contract with the Northeast Florida Regional Planning Council.

Members of the National Hurricane Center in Miami must be acknowledged, particularly Mr. Brian Jarvinen of the Center's Research and Development Center. He generously assisted for one week in February 1983 in making application to the SPLASH II mathematical model computer terminal located in the Center and further assisted in interpreting data output concerning the hazards of hurricanes.

Foremost among other government personnel who assisted in this study were Messrs. Charles Vigh, Ted Newsome, Ron Hilton, and David Elmore of the Jacksonville District Office of the U. S. Army Corps of Engineers. I am equally grateful to Mr. Joseph Halusky, Marine Agent of the Florida Marine Advisory Program in Marineland, Florida.

Mr.Thomas Castiglia, Vice President of Reynolds, Smith and Hills, Architects, Inc. of Jacksonville has my gratitude along with Fire Chief Frank Brunson, City of Jacksonville Beach, Fire Chief Wayne Royal, City of Atlantic Beach, and Fire Chief C. W. Strickland, Town of Orange Park.

I am especially thankful to many volunteers in the Northeast Florida region who conducted a telephone survey which sybsequently was incorporated in this study report as Chapter V. Those whom I single out for organizing the effort in each county are Mrs. Frances Long and Mrs. Helen Keegan of the Jacksonville League of Women Voters, Inc.; Mr. Sam Katz of the Association for Retarded Citizens, Clay, Inc.; Mrs. Elizabeth Kraan of the St. Johns County Council on Aging, Inc.; Mrs. Dot Driggers and Mrs. Francis Frank of the Association for Retarded Citizens of Putnam County, Inc.; and Mr. William Barnes of Big Brothers and Big Sisters of Nassau County, Inc.

I would be remiss indeed if I should fail to acknowledge many volunteers of the Northeast Florida Chapter of the American Red Cross in Jacksonville for volunteering countless hours in data reduction required as a prerequisite for analysis. Appreciation is also due Mr. Mark Stoddard, Disaster Preparedness Coordinator of Clay County for special data gathering.

Although the members of the Technical Advisory Committee as listed have been acknowledged, three must be singled out again for having shared an immeasurable amount of expertise. They are Mr. Terry Griffin, Nassau County's Director of Emergency Services and Chairman of the Technical Advisory Committee, Mr. Robert Blodgett, Duval County's Civil Defense Director, and Mr. Jack Schnabel, Meteorologist-in-Charge, National Weather Service.

Last, but certainly not least, my personal thanks are due to two of my colleagues of the Regional Planning Council who gave valuable advice; they are the Honorable Ward Hancock, Putnam County Commissioner, and the Honorable Merhl Shoemaker, Flagler County Commissioner.

Harry Waldron

Harry Waldron, Chairman
Northeast Florida Regional Planning Council

INTRODUCTION

Florida is recognized as the State in the nation most vulnerable to the destructive effects of a hurricane. The great length of the State's coastline, characterized by low-lying coastal lands and numerous tidal inlets and basins, offers little protection from the hazards produced by hurricanes. Historically, this vulnerability is accentuated by the high probability of the State being targeted each year for a hurricane strike. Further, the State's problem of mitigating the detrimental effects of hurricane hazards increases each year in proportion to the continuing development of coastal communities, particularly those located on relatively unprotected barrier islands. It is estimated that over seven million persons reside in the coastal areas of Florida, the majority of whom have never experienced the effects of a hurricane.

In view of the severity of hurricane hazards, Florida's Department of Community Affairs has embarked on a state-wide program to develop seven coastal regionally-based hurricane evacuation studies and three inland shelter studies. The Northeast Florida Regional Planning Council has contracted with the State to conduct a region-wide Hurricane Evacuation Study in the Council's seven-county area of responsibility.

The report which follows is the first of a two-phase study in preparation since January 1983. The second phase is to be completed by the Regional Planning Council by December 15, 1984. The purpose* of the Study, Phase I and Phase II, is to assist local governments here in Northeast Florida 1) to determine the probable impact of a hurricane striking the region and 2) to provide local decision-makers with technical data to help them measure the critical time elements of an evacuation process, particularly in regard to transportation--the time to move the area's population from areas at risk to safe shelter.

The scope of work and key elements involved in this, the first phase, is summarized as follows:

- Hazard Analysis -- Includes history of hurricane activity in the region, a description of hazards associated with hurricanes, and the results of a computer modeling effort to project prospective storm-surge heights (Chapter I).

- Vulnerability Analysis -- Identifies areas of the region that are subject to the hazards of a hurricane (Chapter II).

- Population Data Analysis -- Provides an estimation of the at-risk population in the region's coastal counties (Chapter III).

*The purpose of the Study, however, is neither to describe how an evacuation should be carried out nor to develop operational procedures for implementing an evacuation; such are functions of county Civil Defense offices.

• Surge Roadway Inundation Analysis -- Analyzes potential saltwater flooding to be expected along roadways that will be used as evacuation routes (Chapter IV).

• Behavioral Survey -- Based on a survey of the threatened population, predicts the probable behavior of coastal residents in a hurricane emergency situation (Chapter V).

• Shelter Inventory -- Describes available resources for sheltering evacuees, and quantifies surpluses/deficits based on probable shelter demand (Chapter VI).

Of the seven counties in Northeast Florida within the Regional Planning Council planning district, the coastal counties of Nassau, Duval, St. Johns, and Flagler are included in Chapters I through III. In addition to these four counties, Clay and Putnam are covered in Chapters IV and V. All seven counties including Baker are incorporated in Chapter VI.

In Phase II, from March to December 15, 1984, the following additional work elements will be completed:

• Evacuation Scenarios -- Develop evacuation zones based upon hazard analysis, access to evacuation routes, geographic location, elevation, city boundaries, and natural and man-made barriers.

• Shelter Assignments -- Assign percentages of potential evacuees in each zone to a presumably safe location such as a specific public shelter.

• Evacuation Routes -- Establish basic evacuation road network related to evacuation zones and the location of area shelters.

• Clearance Time -- Calculate vehicle traveling times required to move threatened population to areas of safety; transportation modeling effort will simulate movement of vehicles on existing highway network that may occur during hurricane evacuations.

• Evacuation Time Estimates -- Determine the time in half-hour segments needed for issuing evacuation orders based on the pre-developed evacuation zones. Relate evacuation time estimates to the warning mechanism used in the region for initiating evacuation movements during a hurricane emergency.

In addition to the foregoing, a special study will be conducted on the St. Johns River, particularly in Duval and Clay Counties, to determine the possible flooding effects of the river and the need for evacuating areas along river banks and tributaries.

Chapter I follows.

CHAPTER I

HAZARD ANALYSIS

HURRICANE ACTIVITY ALONG THE NORTHEAST FLORIDA COAST

The earliest record of hurricane activity in Florida dates from September 19, 1559, when severe winds were recorded for the area near what is now the City of Pensacola. With the exception of scattered reports in early writings, recorded knowledge of hurricanes begins about 1871. Since then reasonably accurate accounts have been maintained of all hurricane tracks which have affected the United States.

Since the turn of the century, 49 hurricanes made landfall on the coast of Florida of which only six came ashore in Northeast Florida. Since 1886, however, 17 hurricanes passed within 100 nautical miles of Jacksonville. As recently as 1964, Hurricane Dora having winds up to 115 miles per hour came ashore at St. Augustine and caused considerable damage in Duval, Nassau, and St. Johns Counties and along the St. Johns River. Table 1 is a listing of the hurricanes which approached within 100 nautical miles of Jacksonville.

HURRICANE DORA (SEPTEMBER 2, 1964 TO SEPTEMBER 25, 1964)

Hurricane Dora is described first and foremost as a case study inasmuch as it is the first hurricane in this century to smash into the Northeast Florida coast directly from the Atlantic Ocean. See Figure 1 on page 3.

During the week from the time the developing storm was first detected about 1,000 miles south-southeast of San Juan, Puerto Rico, Dora gained strength hourly while moving over open ocean on a direct path with Daytona Beach, Florida.

On September 9, 1964, Dora was slightly less than 200 miles east of Cape Canaveral, moving 16 m.p.h. in a west to northwesterly direction. Peak wind velocity near the hurricane's center was estimated at 125 m.p.h. Gale force winds extended nearly 350 miles to the northeast of the "eye", and 100 miles to the southwest. Hurricane watch was in effect from Myrtle Beach, South Carolina, to Fort Lauderdale, Florida; whereas, hurricane warning extended from Brunswick, Georgia, to Stuart, Florida.

While still offshore on September 9th, Hurricane Dora caused damage ashore due to winds and high tides. County Civil Defense Directors reported water over all seawalls along the coast, and wind gusts up to 81 m.p.h. at Marineland and 65 m.p.h. at Mayport Naval Station. The Atlantic and Jacksonville Beach piers were washed away. The storm tidal phenomenon was already taking effect as water at high tide (10:15 a.m.) was hubcap deep on beach municipal streets and backed

(continued on page 4)

TABLE 1

HURRICANES WHICH PASSED WITHIN 100

NAUTICAL MILES OF JACKSONVILLE, 1886-1979

Year	Date		Closest Point (Nautical Miles)	Storm Intensity* (MPH)	Storm Name
1886	July	19	25	90	Not Named
1888	October	10	25	95	"
1893	June	15	59	90	"
1893	August	27	29	120	"
1893	October	12	83	115	"
1894	September	26	29	80	"
1896	September	29	60	90	"
1898	October	2	59	100	"
1899	August	14	83	120	"
1921	October	26	88	105	"
1935	September	4	86	100	"
1950	October	18	52	100	King
1952	August	30	72	90	Able
1960	September	11	47	110	Donna
1964	September	10	30	110	Dora
1968	October	19	35	80	Gladys
1979	September	4	35	98	David

*Refers to average daily maximum wind near the storm center.

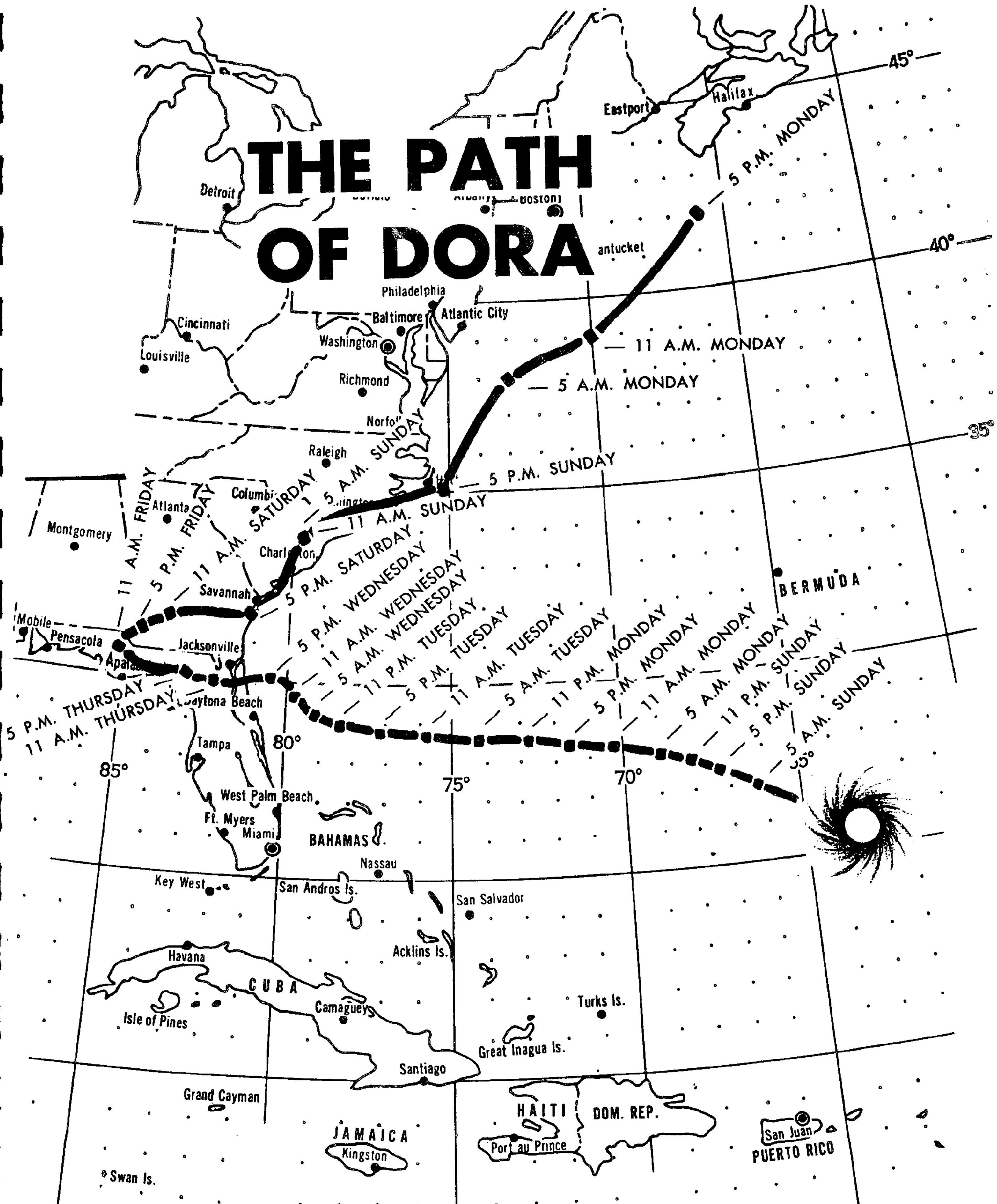

THE PATH
OF DORA
Detroit
Boston
antucket
Eastport
Halifax
5 P.M. MONDAY
Philadelphia
Baltimore
Atlantic City
Washington
Cincinnati
Louisville
Richmond
11 A.M. MONDAY
5 A.M. MONDAY
Raleigh
5 A.M. SUNDAY
5 P.M. SUNDAY
11 A.M. SUNDAY
Atlanta
Columbia
Montgomery
11 A.M. FRIDAY
5 P.M. FRIDAY
11 A.M. SATURDAY
5 P.M. SATURDAY
Savannah
Mobile
Pensacola
Jacksonville
5 P.M. WEDNESDAY
11 A.M. WEDNESDAY
5 A.M. WEDNESDAY
11 P.M. TUESDAY
5 P.M. TUESDAY
11 A.M. TUESDAY
5 A.M. TUESDAY
11 P.M. MONDAY
5 P.M. MONDAY
11 A.M. MONDAY
5 A.M. MONDAY
11 P.M. SUNDAY
5 P.M. SUNDAY
5 A.M. SUNDAY
BERMUDA
5 P.M. THURSDAY
11 A.M. THURSDAY
Daytona Beach
Tampa
80°
85°
75°
70°
45°
40°
35°
West Palm Beach
Ft. Myers
Miami
BAHAMAS
Nassau
Key West
San Andros Is.
San Salvador
Acklins Is.
Havana
CUBA
Camaguey
Isle of Pines
Turks Is.
Great Inagua Is.
Santiago
Grand Cayman
HAITI
DOM. REP.
JAMAICA
Kingston
Port au Prince
San Juan
PUERTO RICO
Swan Is.

FIGURE 1

up for two blocks into the City of Jacksonville Beach. By late afternoon of September 9th, access to beaches along the Northeast Florida coast was cut off as highways and streets flooded.

After stalling about 50 miles offshore for several hours, Hurricane Dora turned northwesterly and came ashore at 12:15 a.m. on September 10, 1964, with the "eye" moving onto shore a short distance north of St. Augustine. Although winds were reported as high as 115 m.p.h., sustained winds were near 100 m.p.h. along the coastline from St. Augustine to Duval County's beaches. The maximum sustained wind at the U.S. Weather Bureau's station at Jacksonville Airport was reported at 82 m.p.h. After coming ashore, Dora moved almost due west across North Florida.

Northeast Florida's beaches sustained major damage. Among structures destroyed or severely damaged in Duval County were the Atlantic Beach Hotel, two major restaurants, a chateau, and a tavern. Major damage was done to the seawall which was broken in many places and portions washed out to sea. Streets and ramps leading to the beaches were severely damaged.

More than 75 private homes along the beaches of Duval, Nassau and St. Johns Counties were destroyed. Fernandina Beach suffered the greatest loss of homes as tides and waves eroded the sand beneath more than fifty homes. In Ponte Vedra Beach, at least 20 homes were swept into the sea. Damage by tidal surge could have been worse; however, the hurricane struck at exactly low tide.

Mainland Jacksonville suffered severe wind damage, particularly to homes, trees, and utilities. The hurricane destroyed forty-two (42) homes and damaged 3,950 others (in the total of Duval County). Electric power was out in at least ninety (90) percent of the county. Although Jacksonville received only 6.26 inches of rain, damage from flooding occurred in the west Jacksonville area and Orange Park, Clay County area between Avondale and Doctors Lake. After the hurricane passed, strong southerly winds caused severe flooding along Heckscher Drive, forcing the evacuation of homes. Total flood damages to homes, agricultural land, roads was estimated at about three million dollars. This did not include shoreline damage. Although no lives were lost, Dora did between $250 and $300 million in property damage in Northeast Florida.

After Dora left Northeast Florida, the hurricane moved across the state to an area south and west of Tallahassee, turned to the northeast, and proceeded in an east-northeasterly course across Georgia toward Savannah. Dora then paralleled the South Carolina and North Carolina coasts exiting at Cape Hatteras on Sunday, September 13, 1964.

In Florida, Dora did extensive flood damage as the hurricane moved west toward Tallahassee. Nearly 19 inches of rain fell on Live Oak, Florida during a 36-hour period. Live Oak came under ten feet of water on its downtown business district and up to 15 feet in low areas of town. About 50 percent of the homes in the city were damaged and the area's corn crop was destroyed. On the west coast of Florida, Crystal River overflowed flooding thirty (30) percent of the Town of Crystal River.

In the way of evacuation and sheltering, Civil Defense officials estimated that 50,000 people in Florida fled the east coast as the hurricane moved up from Cape Canaveral. The Red Cross opened some 220 shelters to house approximately 26,000 people. Inland hotels were filled.

DESCRIPTION OF HURRICANES

A hurricane is an intense cyclonic windstorm of tropical origin in which winds spiral inward in a counter-clockwise direction toward a core of low pressure. According to the Saffir/Simpson Hurricane Scale (see page 6), storms with cyclonic winds of 74 mph or greater are classified as hurricanes. A tropical cyclone with winds less than 74 mph, but with a closed circulation and maximum winds greater than 38 mph, is called a tropical storm. Weaker circulations are referred to as tropical depressions.

The most distinctive feature of the hurricane is the center, or "eye" of the storm. This is the relatively calm area of the storm that is marked by extremely low pressure. Within the eye there is a marked reduction in wind speed, the heavy rain ceases, and there is usually a clearing of the sky. Barometric pressures in the eye have varied from 26.35 inches in the 1935 hurricane which crossed the Florida Keys to over 29 inches in less intense storms.

Surrounding the eye of the hurricane is the wall cloud. This cloud structure may completely encircle the eye and extend from the earth's surface to above 50,000 feet. This cloud system is usually less than 10 miles in width. The strongest winds, the heaviest rainfall, and the greatest pressure changes are in this region.

Outward from the wall cloud region the wind speed decreases slowly. Hurricane force winds usually occur within 50 miles of the center, although in extreme cases they may extend for hundreds of miles. This outer portion of the storm is likely to be marked by bands of sudden gusts of wind and/or rain. Interspersed between these lines of squalls are areas with little or no rain.

Maximum winds usually occur on the right side of the storm at distances varying from 5 to 60 miles from center. In an intense storm sustained wind velocities of 150 miles per hour with gusts of up to 200 miles per hour may be expected at exposed locations on the coast. Wind force decreases substantially as the hurricane moves inland, and sustained winds of over 100 miles per hour are seldom recorded at stations in the interior of the State.

Hurricanes originate over warm waters. The frequency at which hurricanes occur and the location in which they generate vary throughout the June 1st to November 30th hurricane season. Sixteen (16) percent of all hurricanes which affect Florida develop during the month of August, thirty-one (31) percent in September, and thirty-one (31) percent in October. The remaining twenty-two (22) percent occur throughout June, July and November. These figures show that, although a hurricane may strike the Northeast Florida coast anytime between June 1st and November 30th, the highest probability for the occurrence of a hurricane is from mid-August to mid-October.

August and September hurricanes normally form off the coast of North Africa and move west across the Atlantic. Early summer and fall hurricanes form in the Gulf of Mexico and Western Caribbean Sea, then move northeast toward the west coast of Florida.

All hurricanes have the potential to cause extensive damage and loss of life. The manner in which the hurricane storm surge, wind, rain, and other factors combine determines the level of the hurricane's destructive force. The level of threat for the various components of a hurricane occurs in the order of: storm-surge--the storm's greatest potential destructive force, wind--with its potential for associated tornadoes, and rain--causing inland and urban flooding.

STORM-SURGE

The storm-surge is the single most dangerous phenomena caused by the hurricane forces. The term storm-surge refers to the high dome of wind-driven water, 50 to 100 miles wide, that moves across the coastline as a hurricane makes landfall. See Figure 2 on page 8.

The storm-surge develops from a complex interaction of forward speed, angle of hurricane track, and the physical configuration or bathymetry of the ocean basin. It is the effect of bottom friction and the inability of the mass of water to flow down and outward that helps to pile up water and create the surge dome as the hurricane moves over shallow coastal waters. Therefore, the hurricane surge dome has its highest development in areas where the sea bottom has a long, gentle slope up to the shoreline.

The peak of the storm-surge dome, which may extend from 10 to 50 miles north of the hurricane center for storms approaching the east coast of Florida, is counterbalanced by a sea level well below normal on the opposite side of the hurricane center. This difference in water pressure generates strong alongshore currents which tear at the coastal edge often sweeping away sand bars, sand dunes and even buildings.

WIND

Wind can be a lethal component of a hurricane's destructive force. For example, in the 1926 hurricane that hit Miami, Florida, a large percentage of the 115 deaths was due to flying debris. The flying debris came from disintegrating houses which were not constructed to withstand hurricane force winds. The worst hurricane death toll in Florida's history, however, occurred in 1928 when hurricane winds blew the water out of Lake Okeechobee, flooding several communities and drowning nearly 2,000 people.

Hurricanes are categorized according to the intensity of maximum sustained winds around their center or eye. For expediency the National Weather Service has adopted and utilized the Saffir/Simpson Scale, which not only categorizes storms according to sustained winds, but also describes the expected surge heights. The five categories of hurricanes according to the Saffir/Simpson Scale are listed as follow:

Category	Winds (m.p.h.)	Storm-Surge (ft.)
1	74- 95	4-5
2	96-110	6-8
3	111-130	9-12
4	131-155	13-18
5	155 plus	19 plus

In addition to maximum sustained winds, the hurricane wind envelope may contain numerous tornado-strength gusts which can exceed sustained wind intensity by 20 to 50 percent. For example, a hurricane with sustained winds of 100 mph could have associated wind gusts of up to 150 mph. As the force exerted by the wind increases with the square of the wind speed, a 150 mph wind exerts four times, not twice, the force of a 75 mph wind. It is apparent, therefore, that hurricanes associated with wind gusts can cause considerable damage from an otherwise relatively mild hurricane. Often the danger from a Category 1 hurricane is that associated with these accompanying tornadoes within the gale force wind envelope (i.e. 39-73 mph).

RAIN

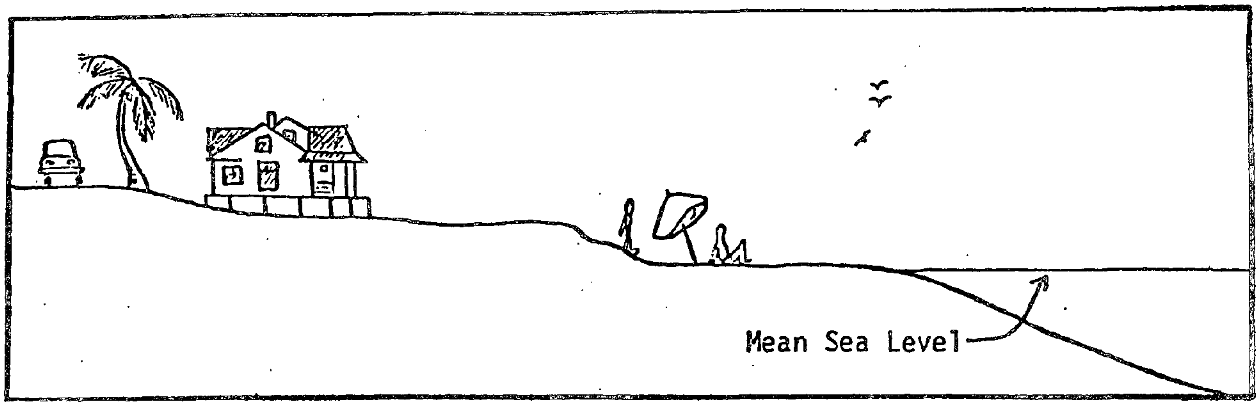
The hurricane's third potentially destructive force is rain. Rain squalls may extend outward as far as 500 miles from the center of a hurricane. The amount of rain that a hurricane may deliver to a region is dependent upon many factors. Three of the most important factors are (1) the angle at which a hurricane approaches landfall, (2) the speed at which the hurricane is traveling, and (3) the radius from the center to which hurricane forces extend--the size of the hurricane.

The speed at which a hurricane is moving and the size of the hurricane dictates how long the storm will remain over an area and, therefore, the time frame during which it has the opportunity to release rainfall on that area. During the average 24-hour period that it takes a hurricane to pass through an area, an average rainfall of between 5 to 10 inches may occur. There have been numerous hurricane rainfalls in Florida experience, however, where 12 to 20 inches of rainfall have occurred. The heaviest rainfall associated with a hurricane in the United States was measured during Hurricane Easy. This storm dropped 38.7 inches of rain at Yankeetown, Cedar Key, during the 24-hour period of September 5 to September 6, 1950.

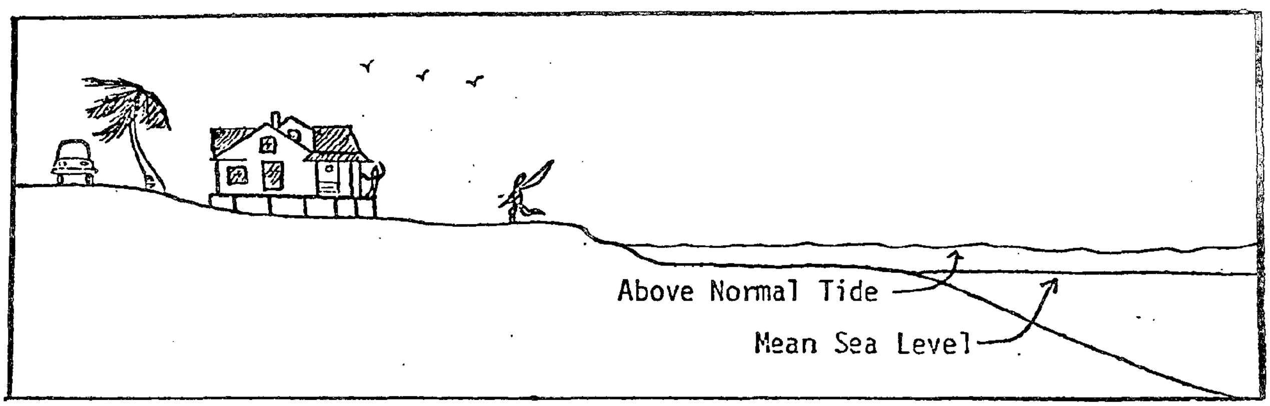
INLET FORMATIONS

Up to a point, the level of threat description has centered on storm surge, wind, and rain. One additional threat which is noteworthy, however, is inlet formations caused by storm surge attack either from the seaward side of barrier islands, or from the lagoon side as the aftermath of a storm surge rushes back to sea (causing a breakthrough of the barrier island).

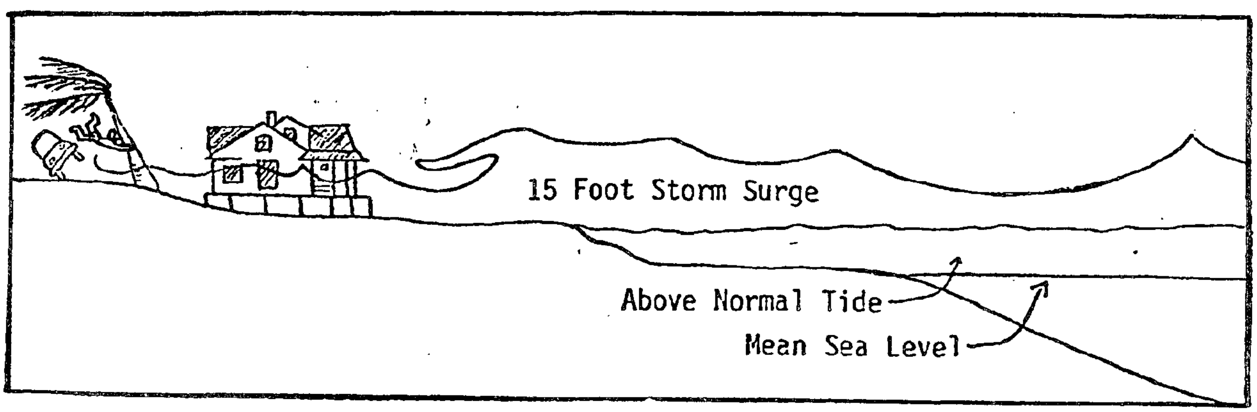
The latter warrants special attention here. After passage of the center of a hurricane, a sometimes rapid wind shift to the offshore direction can take place which lowers the storm surge level on the ocean side of the barrier island; water piled up on the mainland will be left unsupported. It will rush back across a lagoon (or, in the case of Northeast Florida, the Intracoastal Waterway) under the force of gravity, aided by the offshore wind, and slam against the landward side of the barrier island. At certain points, the water may overtop the island, erode a channel below the usual sea level (as the ocean level is now lower than normal) forming a new tidal inlet. See Appendix A, excerpts taken from an abstract entitled "The Formation of Tidal Inlets in Barrier Island Chains", which was developed in 1983 by Steve Hughes, Graduate Assistant, University of Florida.



Normal day. The sea rises and falls with astronomical tidal action. There are the usual small waves.



A hurricane is 12 hours away. The tide is a little above normal; the water moves further up the beach. Swells are beginning to move in from the deep ocean. Waves as high as 5 to 8 feet run up the beach.



Hurricane is moving close ashore. A 15-foot surge is added to the normal 2-foot tide creating a 17-foot storm tide. This mound of water is moving ashore along an area of coastline 50 to 100 miles wide.

FIGURE 2 -- DEVELOPMENT OF STORM-SURGE ALONG THE COASTLINE

HAZARD ANALYSIS

CONCEPTS AND ASSUMPTIONS

Conceptually, this section is based on the effects resulting from the least severe to the most severe of hurricanes which can impact the seven counties of Northeast Florida, particularly the four coastal counties of Duval, Flagler, Nassau and St. Johns. The four coastal counties are emphasized inasmuch as they will bear the brunt of expected surges emanating from most hurricanes reaching the area. By analyzing the effects of all levels of hurricane severity, hazards of any potential magnitude are considered in the planning efforts for warning, evacuation, and sheltering.

Results from the study of various levels of hurricane severity provide a means of quantifying and qualifying the effects of hurricanes, particularly in terms of storm-surge and wind. The use of output data directly influence two main concerns of this Plan which are: the *extent* of the areas threatened by hurricanes, which will require evacuation, and the *time* required for residents in threatened areas to safely evacuate before a hurricane arrives in their respective area or areas.

Inasmuch as the predictive model utilized in this study does not address rainfall nor the frictional drag on the velocity of winds as a hurricane moves inland, two general assumptions follow:

1. All mobile home residents threatened by all categories of hurricanes should evacuate to shelters, and

2. Rainfall sufficient to flood evacuation routes will generally coincide with the arrival of sustained gale force winds.

METHODOLOGY AND APPLICATION

Hypothetical hurricane tracks of varying forward speed and direction were developed in February, 1983 at the National Hurricane Center in Miami, Florida. The track information is given by latitude and longitude coordinates at six-hour intervals. The speed of the hurricane is implicit in the distance between the six-hourly coordinates. Thus, if the six-hourly values are close together, then the hurricane moves slower than if they are further apart. A typical forward speed for hurricanes affecting the Northeast Florida region is 12 mph. In previous studies, it has been shown that hurricanes moving at faster forward speeds produce higher peak storm-surge values than slower moving hurricanes. Also, the angle that the hurricane track makes with the coastline is also important. Hurricanes striking the coast at a 90 degree angle (normal) will produce higher peak surge values than the same hurricanes moving parallel to the coastline.

Along these hypothetical tracks, hurricanes of varying intensity and size were created. The measurement of intensity was given by the difference between the sea level pressure outside the hurricane circulation and the value in the "eye" or center of the hurricane. The value is called the pressure deficit or delta-p.

This value is directly related to the maximum wind speed such that a large delta-p will have a large maximum wind speed. As the water surface pressure gradient and surface wind stress are larger for larger delta-p and maximum winds the peak storm-surge is correspondingly larger.

An estimate of the size of a hurricane was given by the distance from the eye to the maximum wind. This value is called the radius of the maximum wind or RMW. The RMW is very important because a hurricane landfalling normal to a coastline will produce a peak surge at this location on the right side of the hurricane (i.e. observer is moving with the eye and looking forward along the track). Typical values of RMW for hurricanes affecting the Northeast Florida region are 20 miles for category 1-4 hurricanes, and 15 miles for category 5 hurricanes. Thus, the peak surge for a category 3 hurricane landfalling at St. Augustine will be at the south end of Ponte Vedra Beach (some 20 miles north of St. Augustine).

The latitude, longitude, delta-p, and RMW information at six-hourly intervals were coded onto computer data cards and submitted via remote terminal as input to the National Weather Service's IBM 360/195 computer in Suitland, Maryland. The data initializes the computerized mathematical model known by the acronym SPLASH (Special Program to List the Amplitudes of Surges from Hurricanes). The SPLASH model computes storm-surge heights and concomitant wind speed and direction values along gently curving coasts based upon the hypothetical track data entered. See Appendix B for a detailed description of the SPLASH model.

To consider all possible hurricane effects, four different hurricane movements were modeled: landfalling at 90 degrees relative to the coastline, landfalling at 130 degrees relative to the coastline (known also as "slanting"), paralleling, and crossing/exiting. The landfalling, including slanting, hurricanes were modeled in all categories (one through five); whereas, the crossing/exiting and paralleling hurricanes were modeled in categories one through three. As modeled, the crossing/exiting were moving at 15 mph, whereas the rest were moving at 12 mph. Moreover, the hypothetical hurricane tracks for the landfalling, the slanting and the crossing/exiting storms were spaced at 20-mile intervals along the Northeast Florida coast, with peak storm-surge landfalls occurring at five specific coastal points: Flagler Beach, Matanzas Inlet, St. Augustine, Jacksonville Beach, and Amelia Island. Tracks for the paralleling storms were spaced also at 20-mile intervals running along the shoreline, inland, and offshore. The various hurricane tracks are displayed in Figures 3, 4, 5, and 6, starting on page 11.

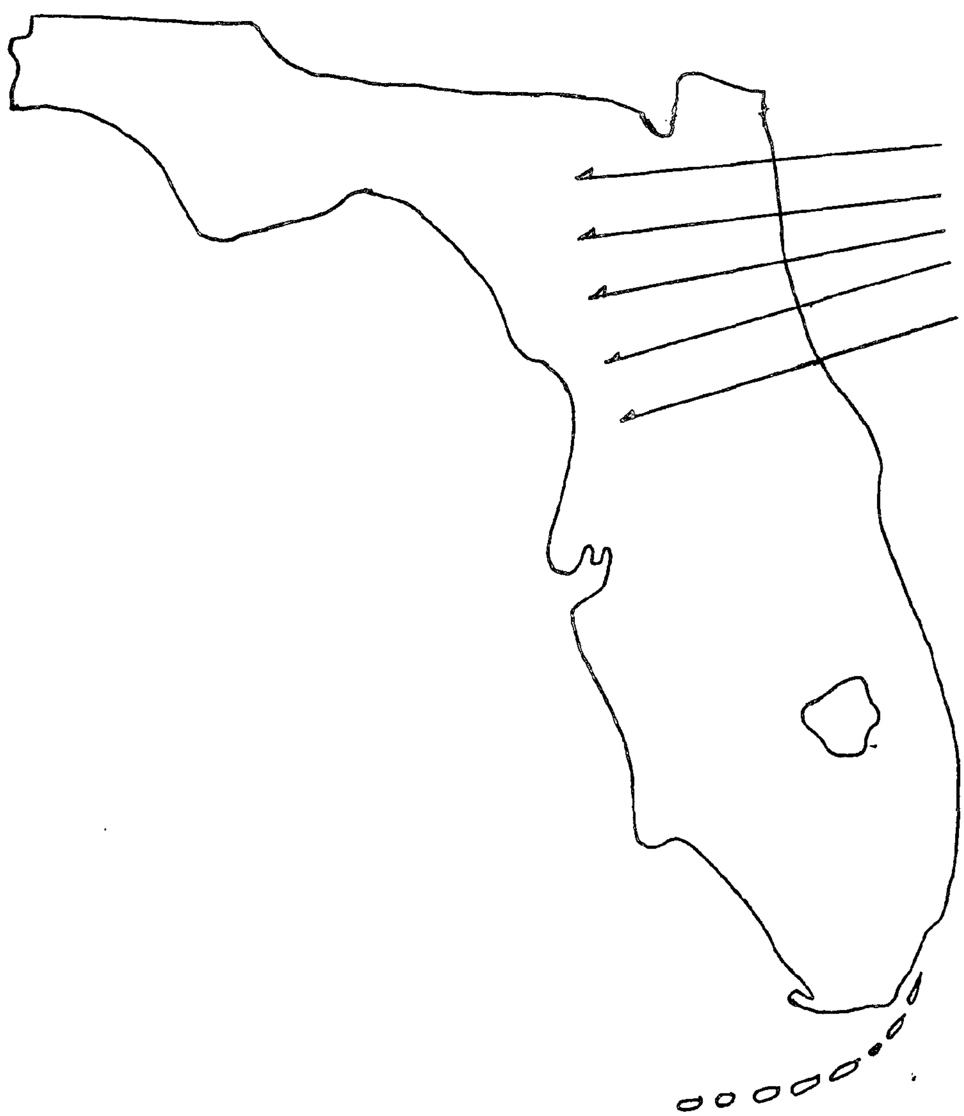


FIGURE 3 -- LANDFALLING HURRICANE TRACKS SELECTED FOR MODELING

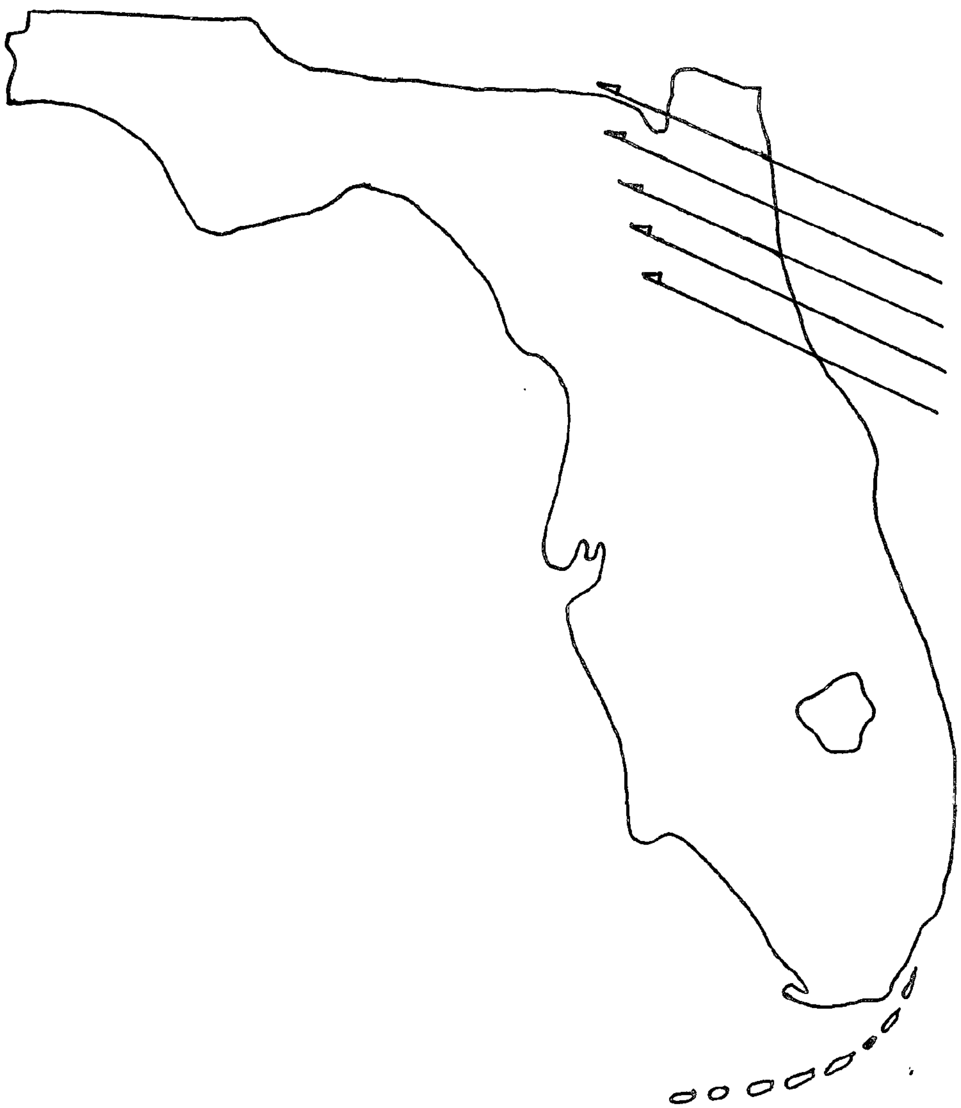


FIGURE 4 -- SLANTING HURRICANE TRACKS SELECTED FOR MODELING

FIGURE 5 -- PARALLELING HURRICANE TRACKS SELECTED FOR MODELING

FIGURE 5 -- PARALLELING HURRICANE TRACKS SELECTED FOR MODELING

FIGURE 5 -- PARALLELING HURRICANE TRACKS SELECTED FOR MODELING

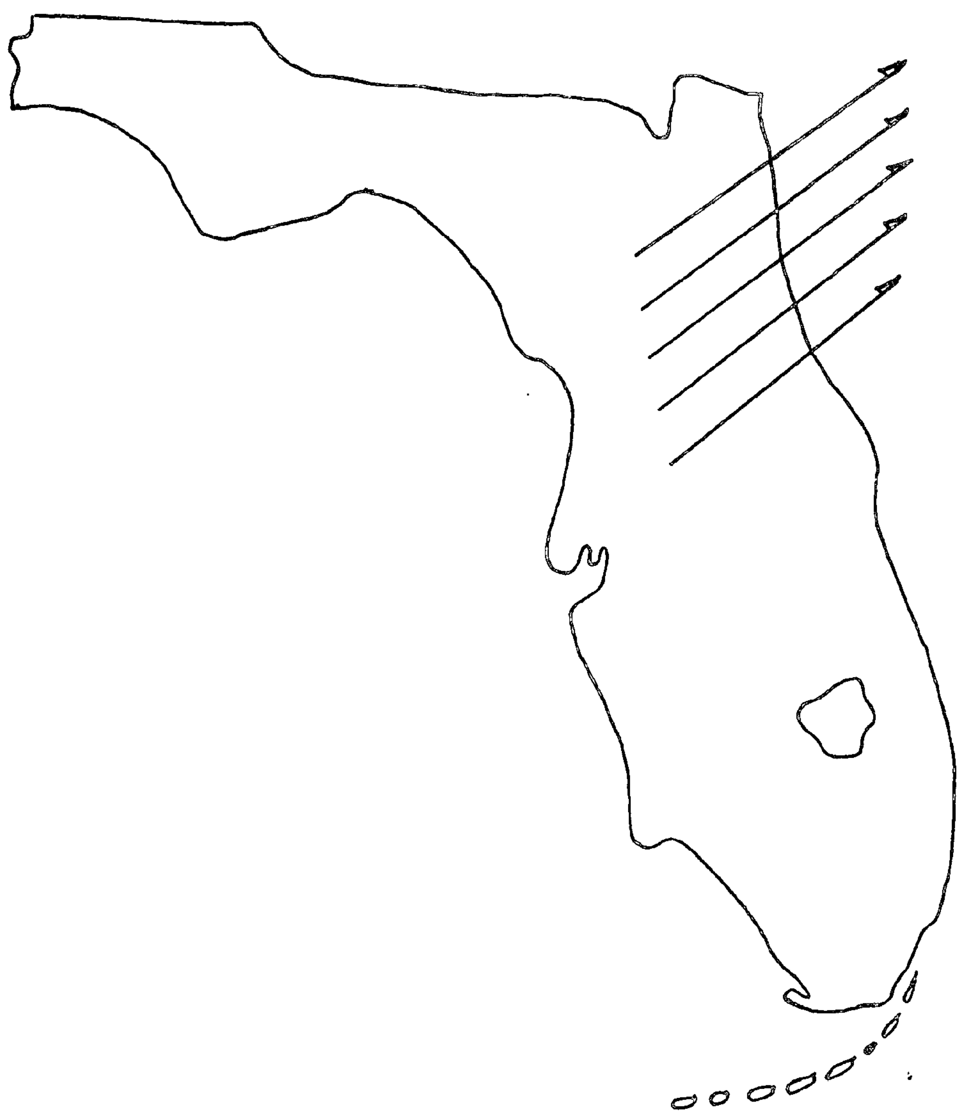


FIGURE 6 -- CROSSING/EXITING HURRICANE TRACKS SELECTED FOR MODELING

OUTPUT OF THE SPLASH MODEL

As stated heretofore, the SPLASH model gives storm-surge and wind predictions for the hypothetical hurricanes entered into the computer. The surge display is presented as a curve which shows peak storm-surge in terms of feet above mean sea level (M.S.L.). The surge printout does not include astronomical tide, the seasonal tide anomaly, or the wind waves riding on the surge. These factors are calculated separately and added to the computer-generated data to determine the storm tide. An example of a storm-surge printout is presented in Figure 7. To identify the peak surge expected at any point along the Northeast Florida coast, individual surges are connected by a line to form an envelope of storm-surges for the entire coastal region. Figure 8 shows a storm-surge envelope for a Category 3 hurricane moving at 12 mph, approaching landfall at 90 degrees relative to the coast. The same Figure 8 shows how the height of the storm-surge increases as it comes ashore at different points up the coast north from Flagler Beach to Fernandina Beach. This increase in storm-surge height is due to the increased width of the continental shelf along the Atlantic Coast. The 60-foot contour (10-fathom curve) of the shelf extends from approximately 15 miles offshore at Flagler Beach to 20 miles offshore at Amelia Island.

An example of the SPLASH model wind output is presented in Figure 9 on page 18. As shown in Figure 9, the hurricane wind envelope contains definite wind bands which decrease in intensity with corresponding distance from the hurricane center. In the SPLASH wind printout (Figure 9), the 40 mph, 75 mph, and maximum wind band - 155+ mph, have been sketched for display. Inasmuch as the maximum sustained winds in Figure 9 are shown to be in excess of 155 mph, the storm is classified as a Category 5 hurricane.

Winds in the Category 5 hurricane form a tight envelope and are generally consistent in intensity within fixed bands around the center or eye. These winds are sufficient to inflict considerable damage. Hurricanes of less than Category 5 wind intensity have a less defined wind envelope. The propensity of the less severe hurricanes to spawn tornadoes increase correspondingly while moving down the scale in intensity from Category 5 to Category 1. Wind gusts within the hurricane wind envelope and tornadoes in the gale force wind field (in less severe hurricanes) oftentime cause more damage than the hurricane's sustained maximum winds.

STORM-SURGE ANALYSES

Using the SPLASH model at the National Hurricane Center, information was developed (and printed out) to analyze and formulate data on peak storm-surge for all five categories of hurricanes, further broken down into landfalling, slanting (landfalling at 130 degrees to coastline), paralleling, and exiting. Tables 2 through 5 beginning on page 19 provide storm-surge analyses. Landfalling and slanting are analyzed for all five categories (of wind intensity), whereas paralleling and exiting are analyzed for categories one, two, and three.

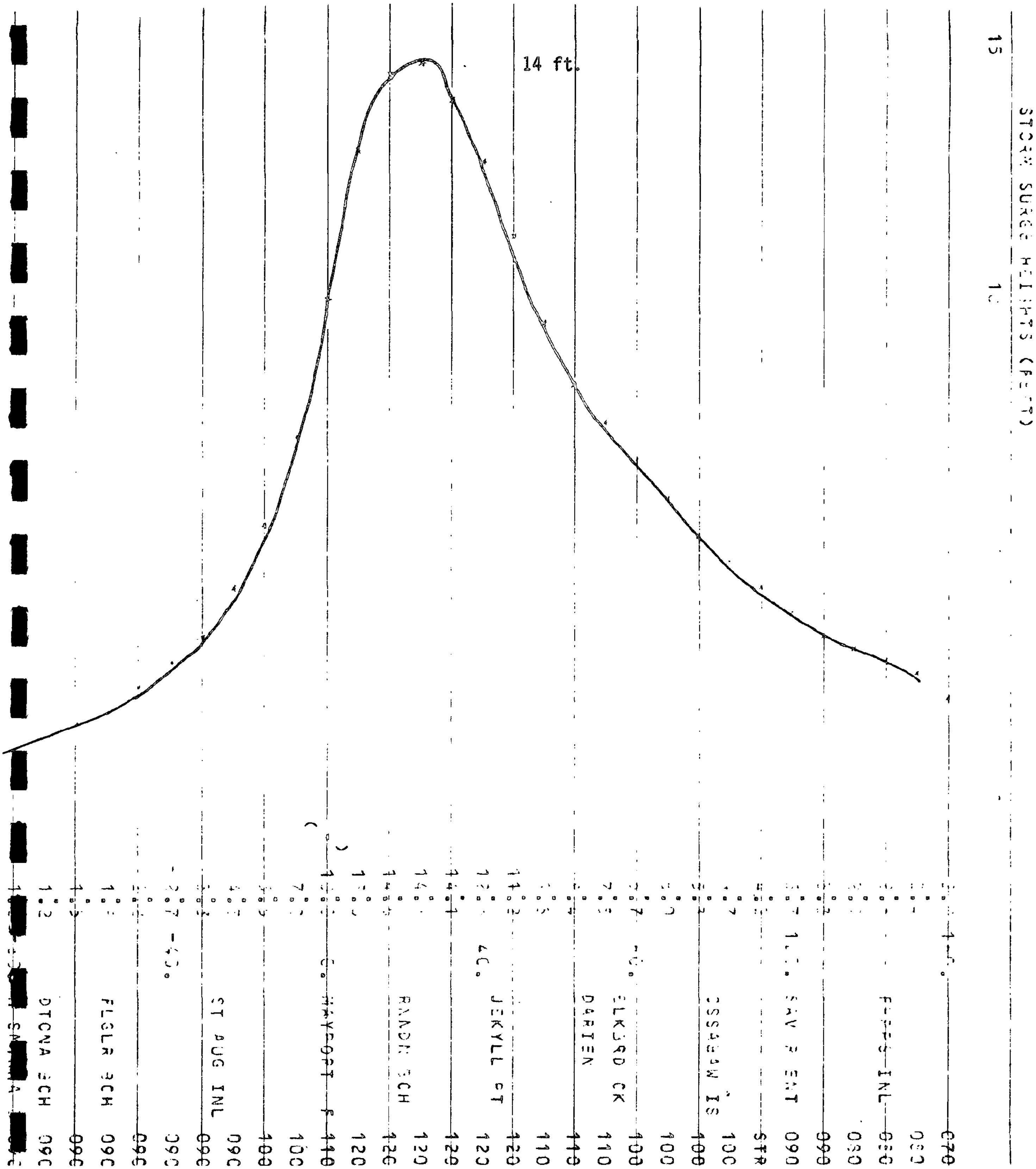


FIGURE 7 -- CATEGORY 3 HURRICANE LANDFALLING AT JACKSONVILLE BEACH
WITH 14-FOOT PEAK SURGE SLIGHTLY NORTH OF FERNANDINA BEACH

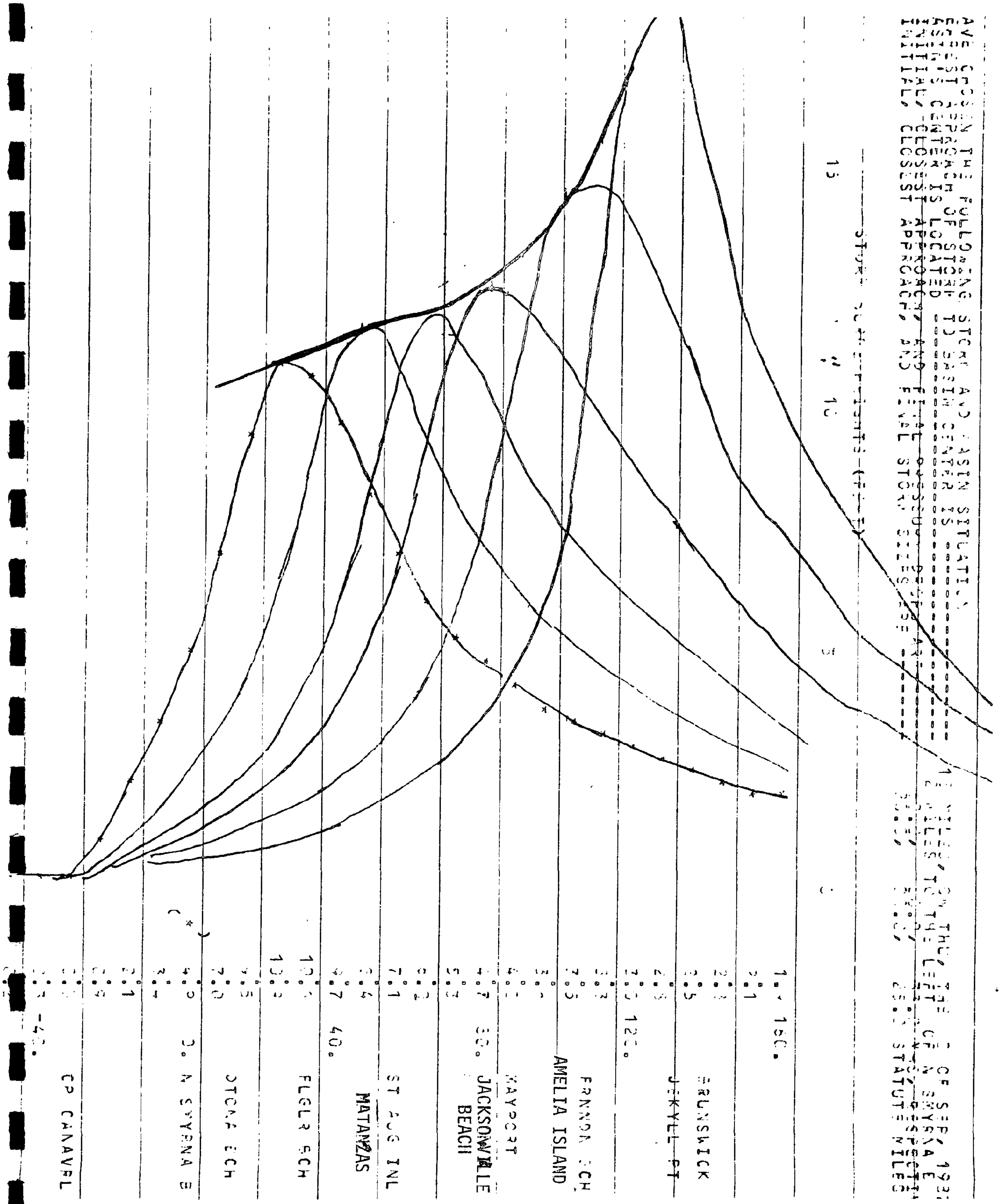


FIGURE 8 -- STORM-SURGE ENVELOPE FLAGLER BEACH TO JEKYLL ISLAND - CATEGORY 3 HURRICANE LANDFALLING 90^0 RELATIVE TO THE COAST

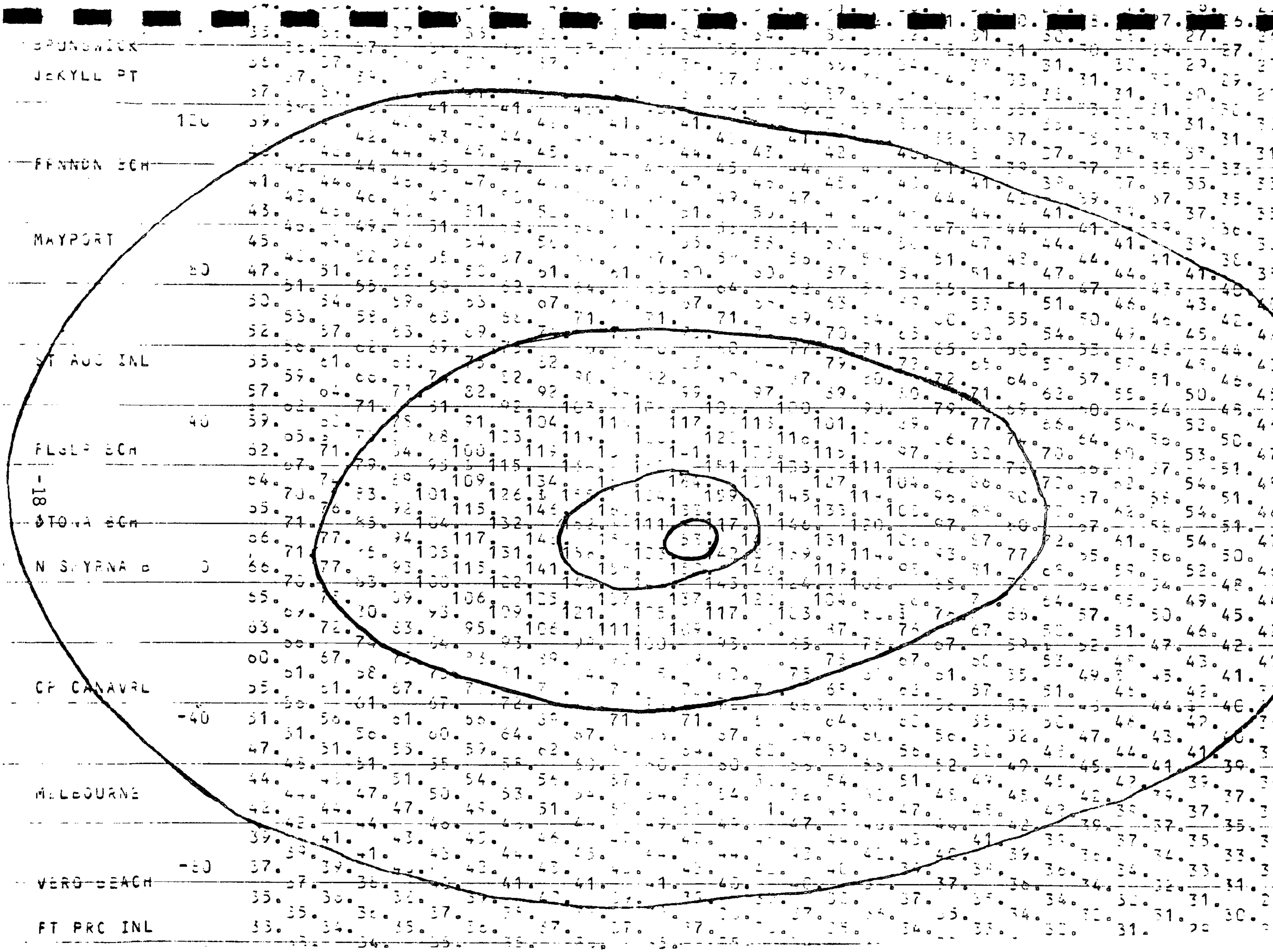


FIGURE 9 — SPLASH MODEL WIND PRINTOUT FOR CATEGORY 5 HURRICANE LANDFALLING AT DAYTONA BEACH

TABLE 2

PROJECTED STORM SURGE HEIGHT

LANDFALLING HURRICANE APPROACHING 90 DEGREES RELATIVE TO COASTLINE

HEADING 250° - 260° TRUE

Point of Hurricane Landfall	Point of Surge Landfall	Offshore Distance to 60-foot curve	Surge Height in Feet (rounded)				
			CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
Daytona Beach	Flagler Beach	15 miles	5	7	11	15	16
Flagler Beach	Matanzas Inlet	16 miles	6	8	12	16	17
Matanzas Inlet	St. Augustine	17 miles	6	8	12	16	17
St. Augustine	Jacksonville Beach	18 miles	6	8	13	17	18
Jacksonville Beach	Amelia Island	20 miles	7	9	14	19	20

Table 3

Projected Storm Surge Height

Slanting (Landfalling) Hurricane Approaching 130 Degrees to Coastline

Heading 300° True

Point of Hurricane Landfall	Point of Surge Landfall	Offshore Distance to 60-foot curve	Surge Height in Feet (rounded)				
			CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
Daytona Beach	Flagler Beach	15 miles	4	6	8	11	13
Flagler Beach	Matanzas Inlet	16 miles	4	6	8	12	13
Matanzas Inlet	St. Augustine	17 miles	5	6	9	12	13
St. Augustine	Jacksonville Beach	18 miles	5	7	10	13	15
Jacksonville Beach	Amelia Island	20 miles	6	8	11	16	18

Table 4

Projected Storm Surge Height

PARALLELING HURRICANE MOVING 20 MILES INLAND FROM SHORELINE

Point of Hurricane (20 miles inland)	Point of Surge Landfall	Offshore Distance to 60-foot curve	Surge Height in Feet (rounded)		
			CAT 1	CAT 2	CAT 3
Daytona Beach	Flagler Beach	15 miles	2	3	5
Flagler Beach	Matanzas Inlet	16 miles	3	3	5
Matanzas Inlet	St. Augustine	17 miles	3	3	5
St. Augustine	Jacksonville Beach	18 miles	3	4	6
Jacksonville Beach	Amelia Island	20 miles	4	5	7

PARALLELING HURRICANE MOVING ON SHORELINE

Point of Hurricane (moving on shoreline)	Point of Surge Landfall	Offshore Distance to 60-foot curve	Surge Height in Feet (rounded)		
			CAT 1	CAT 2	CAT 3
Daytona Beach	Flagler Beach	15 miles	3	4	7
Flagler Beach	Matanzas Inlet	16 miles	3	5	7
Matanzas Inlet	St. Augustine	17 miles	3	5	7
St. Augustine	Jacksonville Beach	18 miles	4	5	8
Jacksonville Beach	Amelia Island	20 miles	4	6	9

Table 4 (Continued)

PARALLELING HURRICANE MOVING 20 MILES OFFSHORE

Point of Hurricane (20 miles offshore)	Point of Surge Landfall	Offshore Distance to 60-foot curve	Surge Height in Feet (rounded) CAT 1	CAT 2	CAT 3
Daytona Beach	Flagler Beach	15 miles	3	3	6
Flagler Beach	Matanzas Inlet	16 miles	3	4	6
Matanzas Inlet	St. Augustine	17 miles	3	4	6
St. Augustine	Jacksonville Beach	18 miles	3	4	6
Jacksonville Beach	Amelia Island	20 miles	3	4	7

PARALLELING HURRICANE MOVING 40 MILES OFFSHORE

Point of Hurricane (40 miles offshore)	Point of Surge Landfall	Offshore Distance to 60-foot curve	Surge Height in Feet (rounded) CAT 1	CAT 2	CAT 3
Daytona Beach	Flagler Beach	15 miles	1	2	4
Flagler Beach	Matanzas Inlet	16 miles	2	2	4
Matanzas Inlet	St. Augustine	17 miles	2	2	4
St. Augustine	Jacksonville Beach	18 miles	2	3	4
Jacksonville Beach	Amelia Island	20 miles	2	3	4

Table 5

Projected Storm Surge Height

CROSSING HURRICANE EXITING COAST HEADING 045^0 TRUE

Point of Hurricane Exiting	Point of Surge Landfall	Offshore Distance to 60-foot curve	Surge Height in Feet (rounded)		
			CAT 1	CAT 2	CAT 3
Daytona Beach	Flagler Beach	15 miles	3	4	6
Flagler Beach	Matanzas Inlet	16 miles	3	4	6
Matanzas Inlet	St. Augustine	17 miles	3	4	6
St. Augustine	Jacksonville Beach	18 miles	3	4	7
Jacksonville Beach	Amelia Island	20 miles	4	5	8

Figures in the tables make it clear that the height of a storm-surge decreases in proportion to the increase of a hurricane's angle of approach. For example, a Category 3 hurricane approaching St. Augustine 90 degrees relative to the coastline will produce a storm-surge height of 13 feet at Jacksonville Beach. A Category 3 hurricane approaching 130 degrees will produce a storm-surge height of 10 feet at Jacksonville Beach. A paralleling Category 3 hurricane moving on shoreline at St. Augustine, however, will produce a storm-surge height of 8 feet at Jacksonville Beach.

WIND ANALYSIS

The movement of winds during a hurricane will have two detrimental effects in addition to creating a storm-surge. First, maximum winds and wind gusts inflict considerable damage to many mobile homes, manufactured homes, and other structures of untested hurricane integrity. Second, the level of wind intensity affects the ability of a region to carry out hurricane evacuation procedures. Travel by automobile or larger vehicles becomes decidedly difficult and dangerous in winds greater than 40 m.p.h. The example of a hurricane's wind bands presented in Figure 10 graphically shows the amount of time which is available to conduct an evacuation based upon the landfall of 40 and 75 m.p.h. wind bands for a hypothetical Category 3 hurricane moving 90 degrees relative to the coastline. For simplicity of presentation, Figure 10 shows a hurricane whose center line lies 144 miles offshore and whose forward motion toward landfall is 12 m.p.h. Calculation of the example shows that the center or "eye" of this hypothetical hurricane is 12 hours from landfall. This is significant inasmuch as Neil Frank, Ph.D., Executive Director of the National Hurricane Center has expressed that the Hurricane Center can give (with some level of assurance) up to 12 hours warning that a hurricane will make landfall at a particular location.

Calculating movement-to-time for the hypothetical Category 3 hurricane shown in Figure 10, it can be seen that the 40 m.p.h. band will make landfall less than five hours after an official warning message is issued. Thereafter, evacuation will become dangerous and difficult. Similarly, Figure 10 on the next page shows that the 75 m.p.h. gale wind bank will make landfall eight hours after the National Hurricane Center issues the warning message.

Based upon data produced by the SPLASH model, time before landfall has been calculated for the five levels of hurricane intensity (Categories 1 through 5), using a typical 12 m.p.h. forward motion of a hurricane landfalling 90 degrees relative to the coastline, as well as that for a hurricane with a 15 m.p.h. forward motion. The results of these categories are presented in Table 6 on page 26.

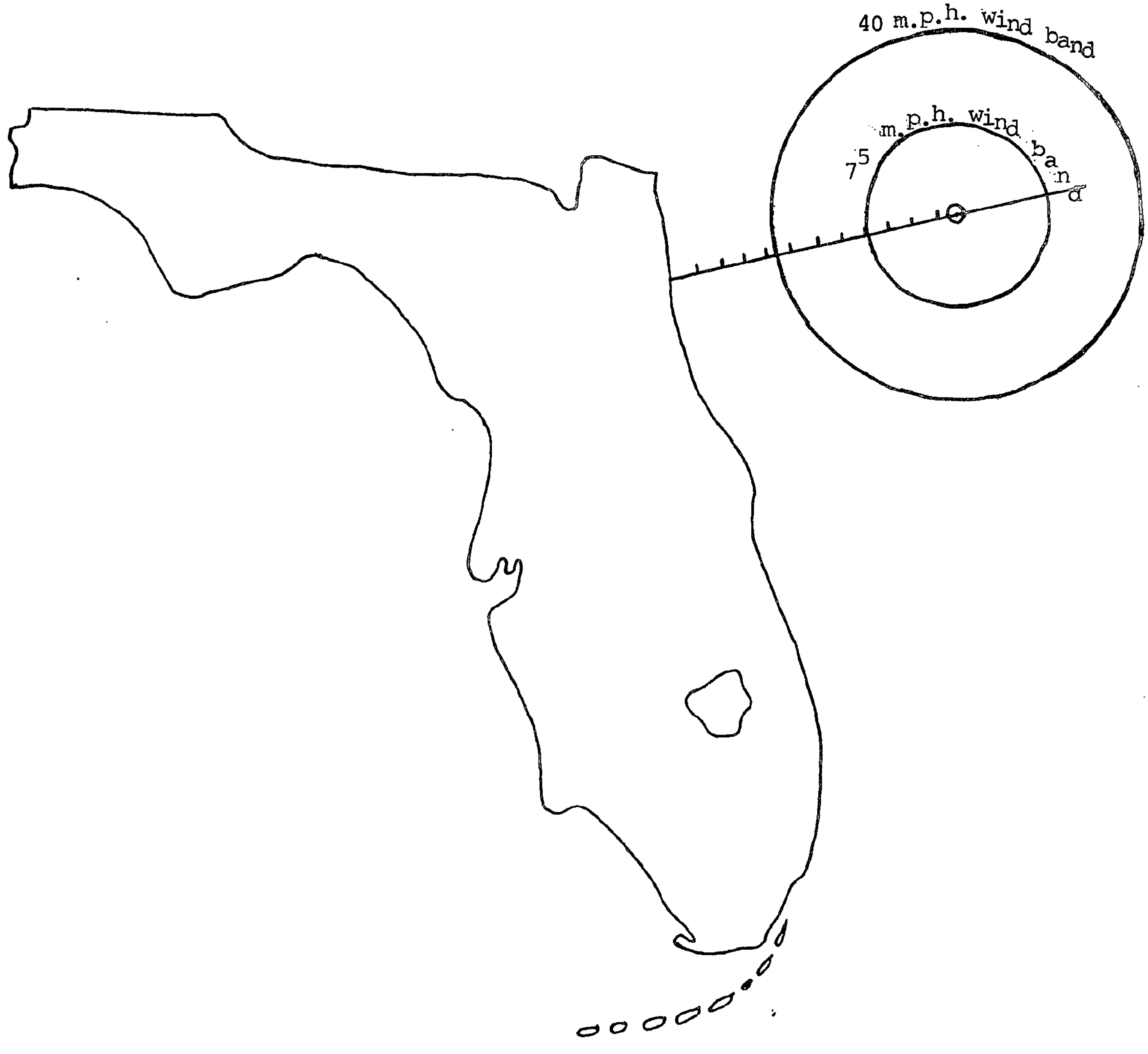


FIGURE 10-- CATEGORY 3 HURRICANE MOVING TOWARD ST. AUGUSTINE AT 12 M.P.H.

TABLE 6

PRE-LANDFALL HAZARD TIME FOR HURRICANE WINDS

LANDFALLING HURRICANE WITH FORWARD MOTION OF 12 M.P.H.

Category of Hurricane	40 M.P.H. Winds: Diameter of Wind Band (Miles)	40 M.P.H. Winds: Available Time Before Landfall (Hours)	75 M.P.H. Winds: Diameter of Wind Band (Miles)	75 M.P.H. Winds: Available Time Before Landfall (Hours)
1	144	6	48	10
2	168	5	72	9
3	192	4	96	8
4	264	2	120	7
5	228	2	120	7

LANDFALLING HURRICANE WITH FORWARD MOTION OF 15 M.P.H.

Category of Hurricane	40 M.P.H. Winds: Diameter of Wind Band (Miles)	40 M.P.H. Winds: Available Time Before Landfall (Hours)	75 M.P.H. Winds: Diameter of Wind Band (Miles)	75 M.P.H. Winds: Available Time Before Landfall (Hours)
1	144	5	48	8
2	168	4	72	7
3	192	3	96	3
4	264	1	120	2
5	228	2	120	2

The diameter of the wind band is dependent upon the category of hurricane.
The variables of distance offshore and speed of forward motion may be adjusted to produce new estimates of available time before landfall for various conditions using the simple equation:

$$\text{Available time before landfall} = \frac{DHL - \frac{1}{2} DW}{FM}$$

Where DHL = Distance of Hurricane Center from landfall (Miles)
FM = Forward Motion of Storm (Miles-per-hour)
DW = Distance of Wind Band

CHAPTER II VULNERABILITY ANALYSIS

Chapter I constituted an analysis of hurricane hazards which conceivably could impact Northeast Florida, with an emphasis on peak surge. Chapter II hereafter identifies land mass areas which could be at risk as affected by the storm-surge.

METHODOLOGY

Identification of the coastal areas which are vulnerable to a hurricane's storm-surge is necessary for determining those residents who must evacuate (from the coastal area). As shown in Chapter I, the results from the SPLASH II model provided the data necessary to identify the vulnerable areas. Here in Chapter II, peak surge values produced by the SPLASH II model are compared to the elevations of land mass. A major limitation of SPLASH II, however, is the fact that values are produced only for the coast to the shoreline, but not inland. To compensate, a number of additional sources are utilized in producing the vulnerability analysis. These include:

- National Oceanographic Survey Storm Evacuation Maps
- U.S. Geological Survey Topographic Maps
- Federal Emergency Management Administration Flood Insurance Rate Maps
- Beach and Offshore Profile Analyses (topographic cross sections) conducted by the Coastal and Oceanographic Engineering Laboratory, University of Florida
- Aerial photography obtained by the U.S. Geological Survey for the Corps of Engineers, and aerial photography prepared by the State Topographic Office, Florida Department of Transportation.

To determine the worst case storm-surge values, the astronomical high tide, the anomaly, and the wave set are added to the stillwater surge values (which were produced by SPLASH II). In that regard, Tables 7 through 10 present total storm-surge peaks for hypothetical hurricanes making landfall at five points along the Northeast Coast. Tables 11 through 14 present the same data for hypothetical paralleling hurricanes moving directly over the shoreline. In addition, the storm-surge peaks are depicted graphically in Figures 11 and 12.

Storm-surge inundation maps 1 through 11 found at the end of this chapter graphically detail land mass along the Northeast Florida Coast which is subject to worst case inundation by storm-surge, according to the categories of hurricane landfalling. Paralleling hurricanes in Categories 2 and 3 moving on shoreline will have the same inundation effect as a Category 2 landfalling hurricane (approaching 90 degrees relative to the coastline).

Figure 13 on page 35 is an index to the storm-surge inundation maps. It is noteworthy that the storm-surge inundation maps show an overall view of the level of inundation that could result anywhere along the entire Northeast Florida coast, depending on where a hurricane might landfall. In addition, flood prone areas also are depicted on each of the maps to point out the total hazardous picture in the event of a hurricane. The assumption here is that rains coupled with high tidal levels (not to be confused with total storm surge) will impede the movement of vehicles as roads will be flooded. Then too, property lying in flood prone areas is subject to damage.

RECOMMENDATIONS

In the way of mitigating the hazards of hurricanes, it is recommended that local governments:

1. Take measures as necessary to preserve existing primary dunes, to prohibit excavation or other development on the landward toe of any primary dune, to prohibit breaches of primary dunes, and to fill and stabilize existing breaches of primary dunes with vegetation.

2. Stipulate in the approval of developments located within a hurricane hazard (vulnerable) area that all title transfers to property shall be accompanied by a hazard disclosure statement that the property in the particular development is within a hurricane hazard area in which property is subject to damage and residents may be subject to an evacuation order in the event of a hurricane landfalling within 50 miles of the development.

TABLE 7

PROJECTED STORM-SURGE HEIGHT

AMELIA ISLAND

LANDFALLING HURRICANE APPROACHING 90 DEGREES

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	7	3	.5	.9	11
CAT 2	9	3	.5	1.2	14
CAT 3	14	3	.5	1.8	19
CAT 4	19	3	.5	2.4	25
CAT 5	20	3	.5	2.5	26

TABLE 8

PROJECTED STORM-SURGE HEIGHT

JACKSONVILLE BEACH

LANDFALLING HURRICANE APPROACHING 90 DEGREES

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	6	3	.5	.8	10
CAT 2	8	3	.5	1.0	13
CAT 3	13	3	.5	1.7	18
CAT 4	17	3	.5	2.2	23
CAT 5	18	3	.5	2.3	24

Table 9

Projected Storm-Surge Height

St. Augustine and Matanzas Inlet

Landfalling Hurricane Approaching 90 Degrees

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	6	2.5	.5	.8	10
CAT 2	8	2.5	.5	1.0	12
CAT 3	12	2.5	.5	1.6	17
CAT 4	16	2.5	.5	2.0	21
CAT 5	17	2.5	.5	2.2	22

Table 10

Projected Storm-Surge Height

Flagler Beach

Landfalling Hurricane Approaching 90 Degrees

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	5	2.5	.5	.7	9
CAT 2	7	2.5	.5	.9	11
CAT 3	11	2.5	.5	1.4	15
CAT 4	15	2.5	.5	1.9	20
CAT 5	16	2.5	.5	2.0	21

Table 11

Projected Storm-Surge Height

Amelia Island

Paralleling Hurricane Moving On Shoreline

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	4	3.0	.5	.6	8
CAT 2	6	3.0	.5	.8	10
CAT 3	3	3.0	.5	1.2	14

Table 12

Projected Storm-Surge Height

Jacksonville Beach

Paralleling Hurricane Moving On Shoreline

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	4	3.0	.5	.6	8
CAT 2	5	3.0	.5	.7	9
CAT 3	8	3.0	.5	1.1	13

Table 13

Projected Storm-Surge Height

St. Augustine and Matanzas Inlet

Paralleling Hurricane Moving On Shoreline

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	3	2.5	.5	.4	6
CAT 2	5	2.5	.5	.7	9
CAT 3	7	2.5	.5	.9	11

Table 14

Projected Storm-Surge Height

Flagler Beach

Paralleling Hurricane Moving On Shoreline

	Stillwater Surge ft.	Tide (MHW) ft.	Anomaly ft.	Wave Set ft.	Storm-Surge ft.
CAT 1	3	2.5	.5	.4	6
CAT 2	4	2.5	.5	.6	8
CAT 3	7	2.5	.5	.9	11

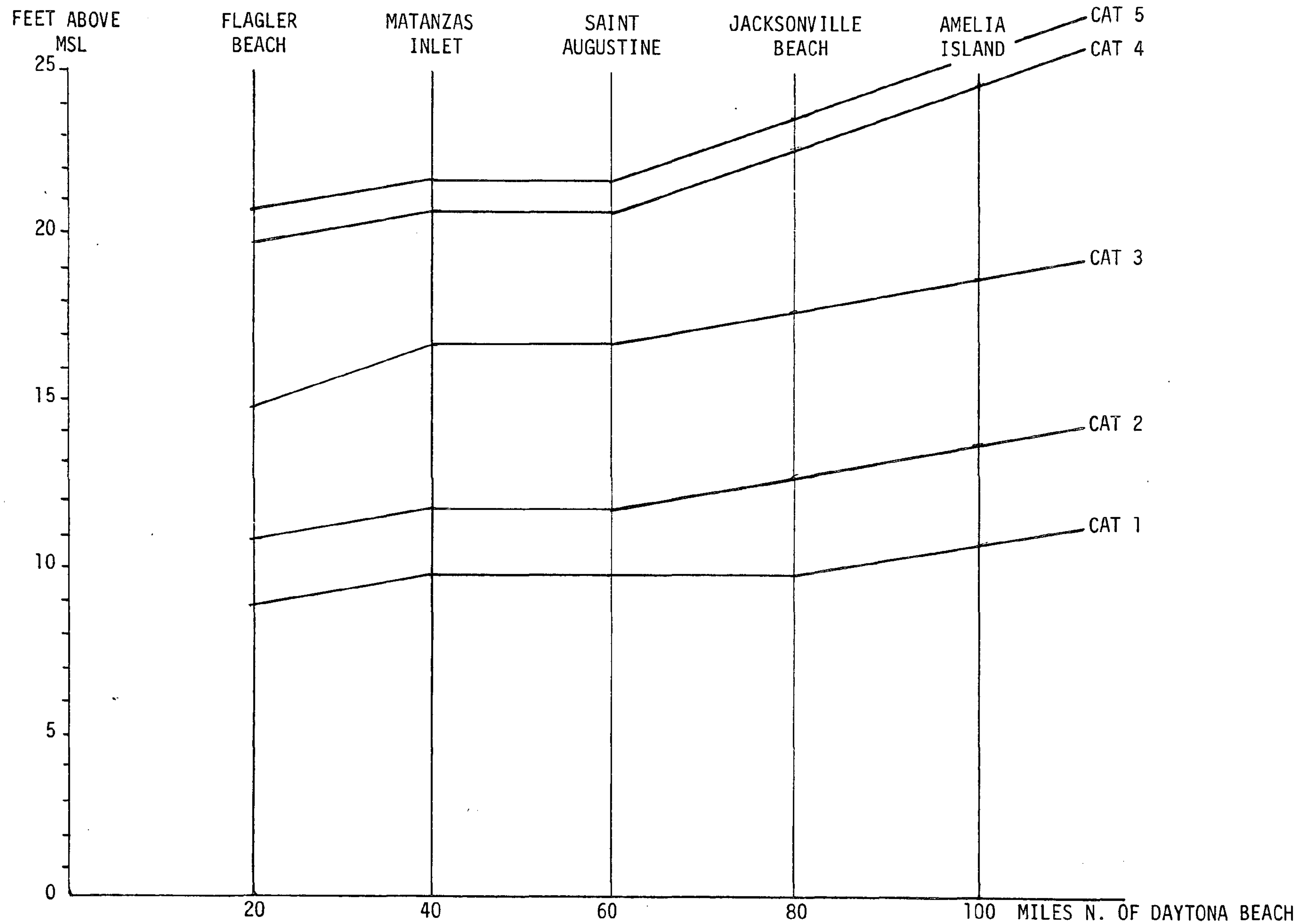


FIGURE 11 LANDFALLING HURRICANE STORM-SURGE

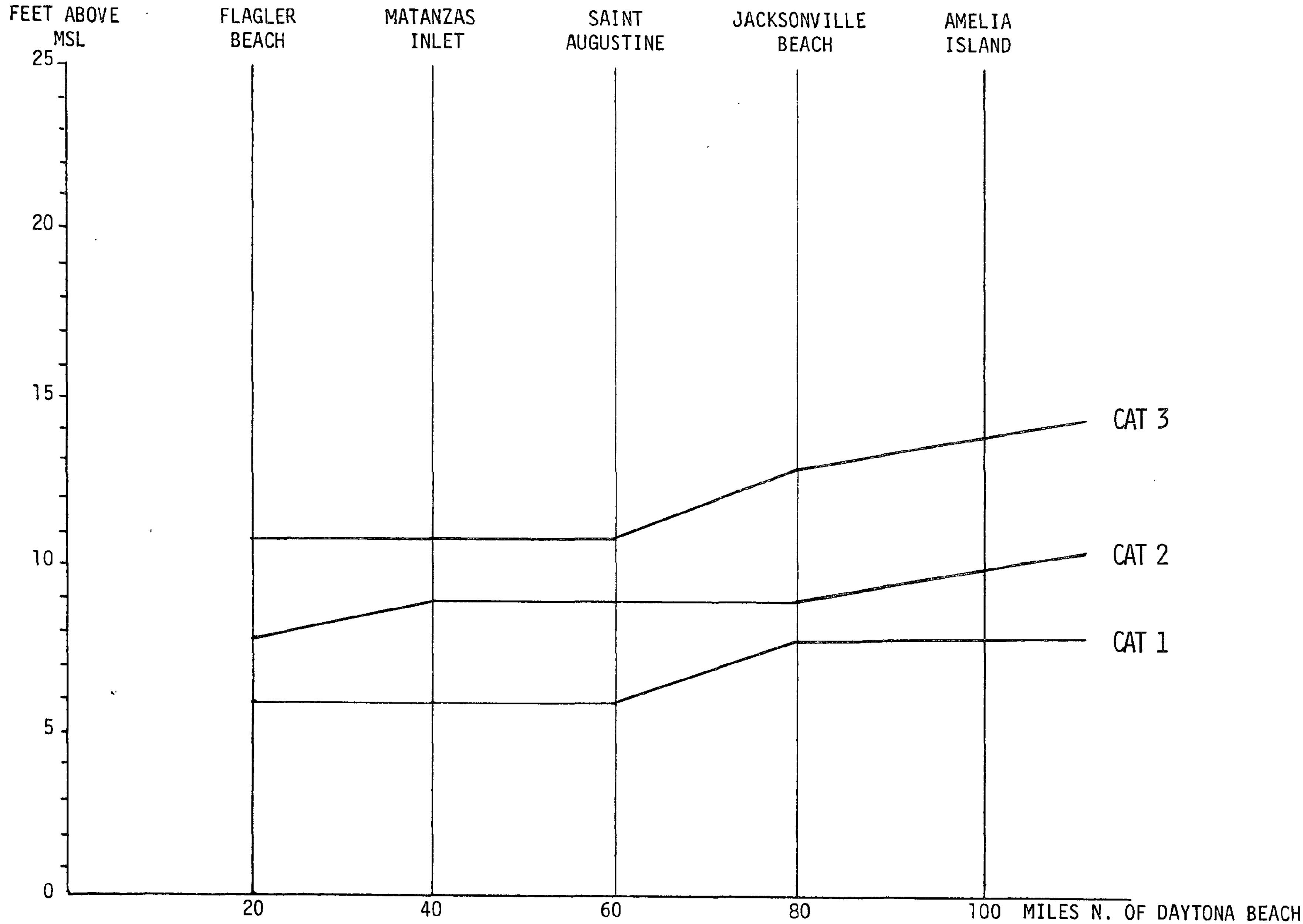


FIGURE 12 PARALLELING HURRICANE STORM-SURGE

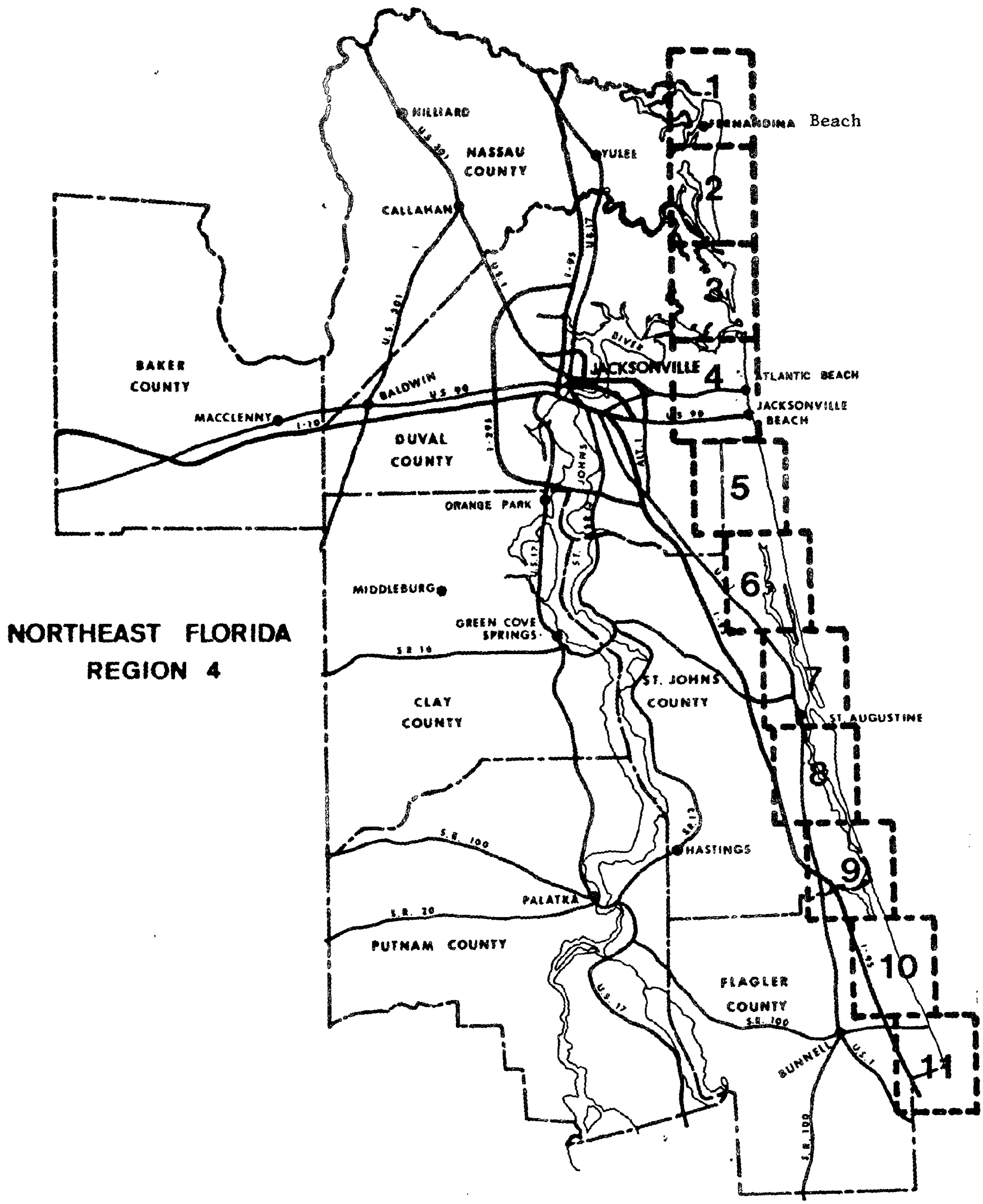
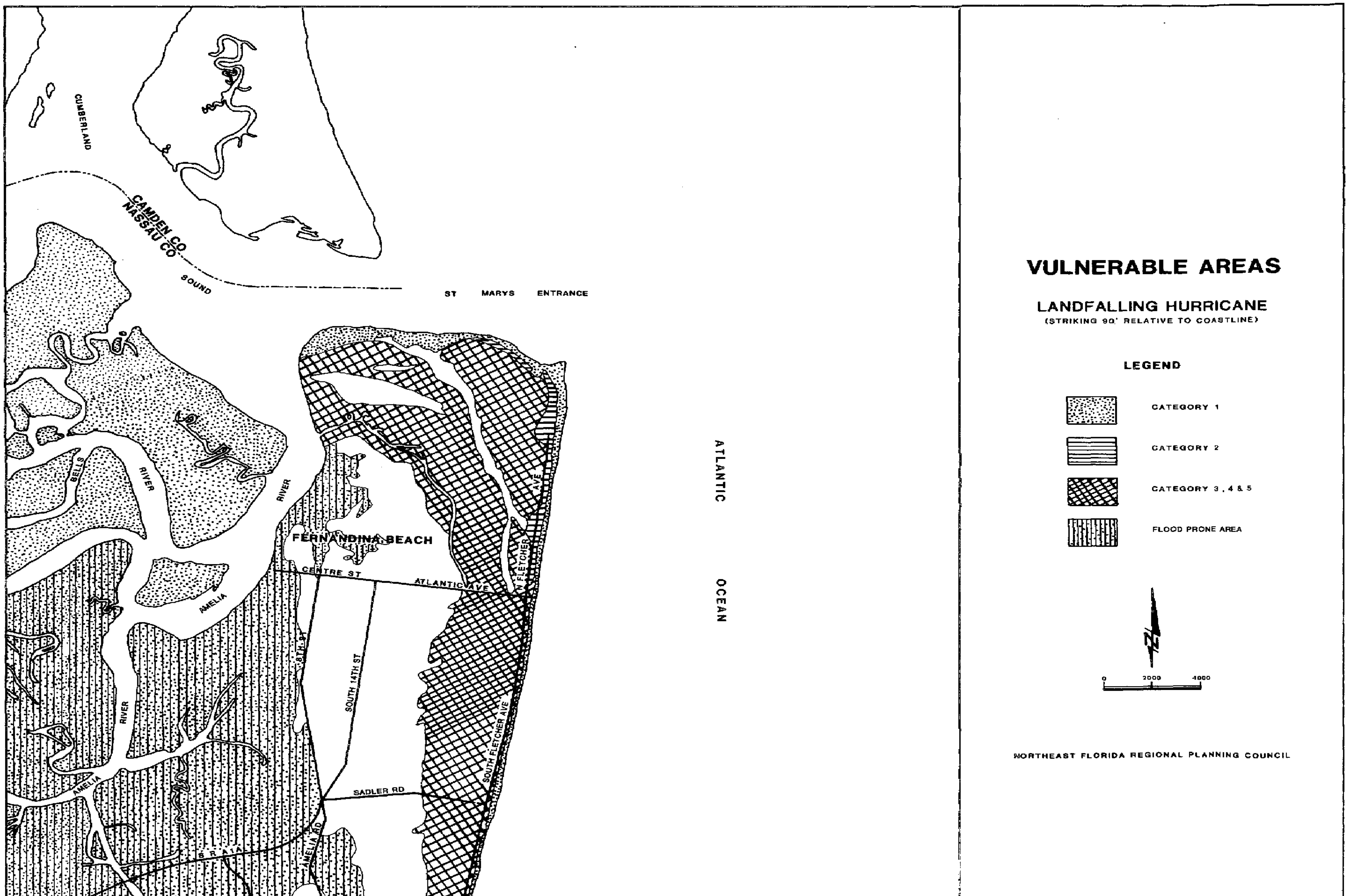
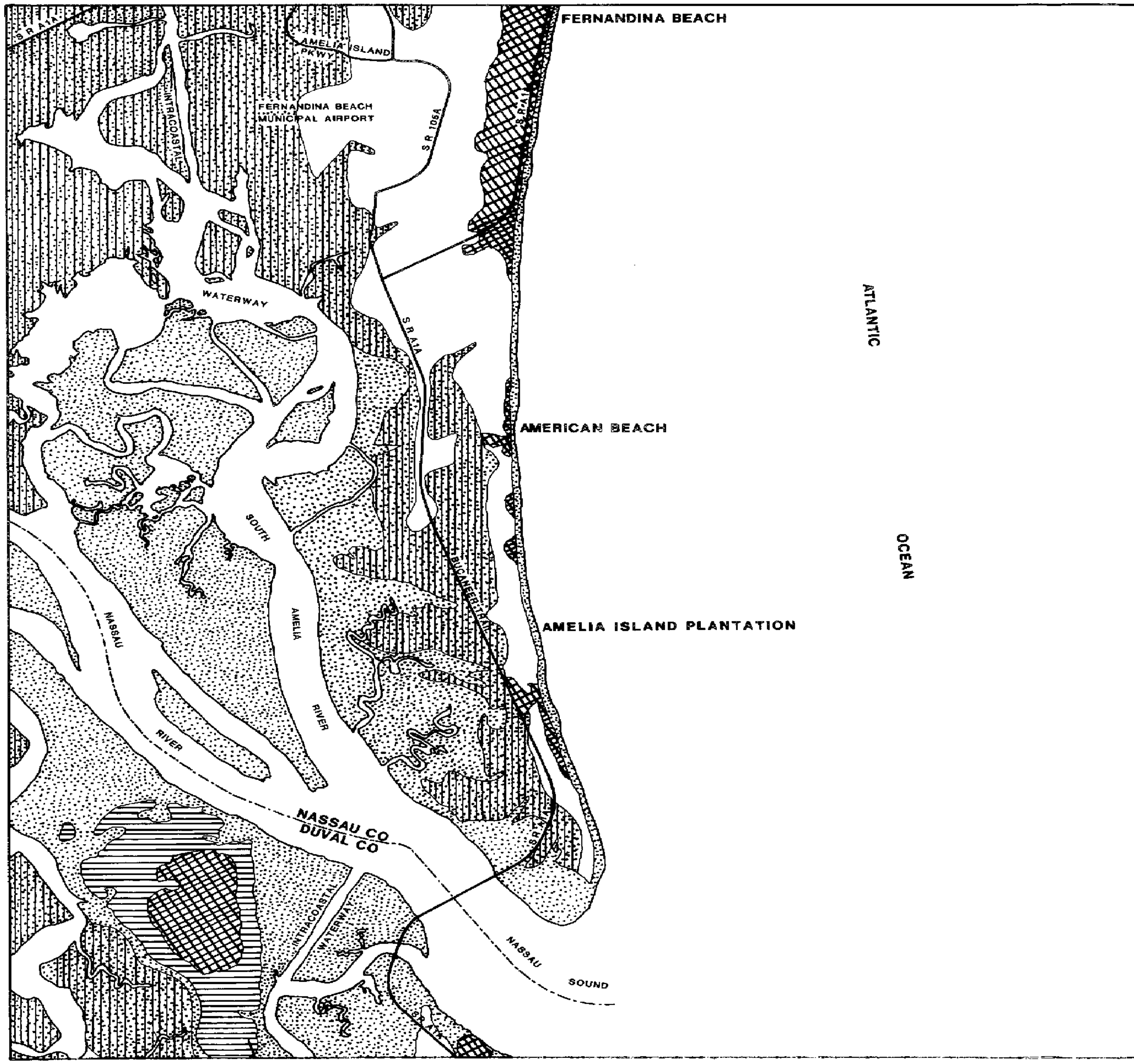


FIGURE 13 INDEX TO STORM-SURGE INUNDATION MAPS


CUMBERLAND
CAMDEN CO
NASSAU CO
SOUND
ST MARYS ENTRANCE
BELLS
RIVER
AMELIA
RIVER
AMELIA
RIVER
FERNANDINA BEACH
CENTRE ST
ATLANTIC AVE
N FLETCHER AVE
8TH ST
SOUTH 14TH ST
SADLER RD
AMELIA RD
SOUTH FLETCHER AVE
ATLANTIC OCEAN
VULNERABLE AREAS
LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)
LEGEND
CATEGORY 1
CATEGORY 2
CATEGORY 3, 4 & 5
FLOOD PRONE AREA
N
0 2000 4000
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL

MAP 1



VULNERABLE AREAS

LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)

LEGEND

CATEGORY 1

CATEGORY 2

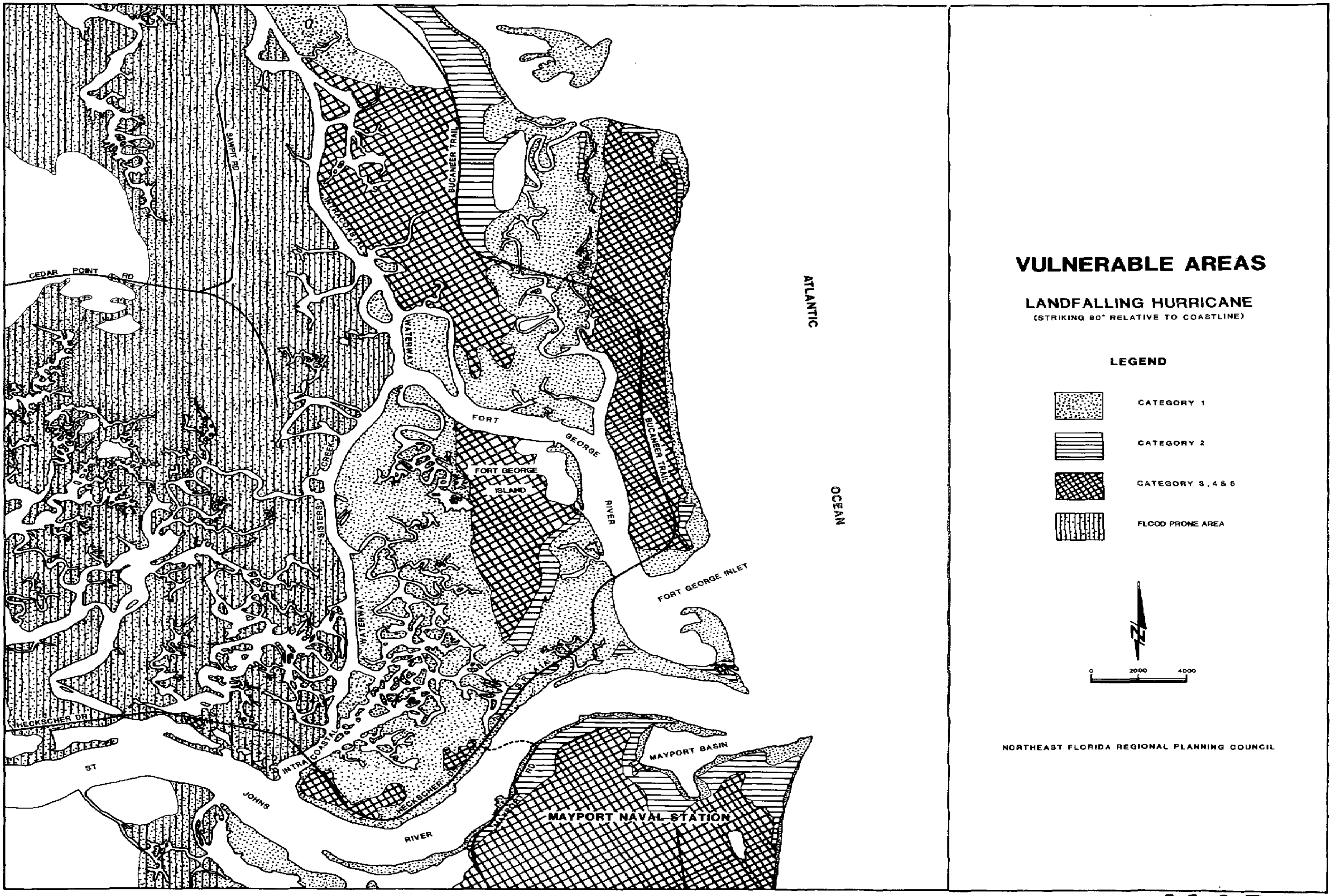
CATEGORY 3, 4 & 5

FLOOD PRONE AREA

0 2000 4000

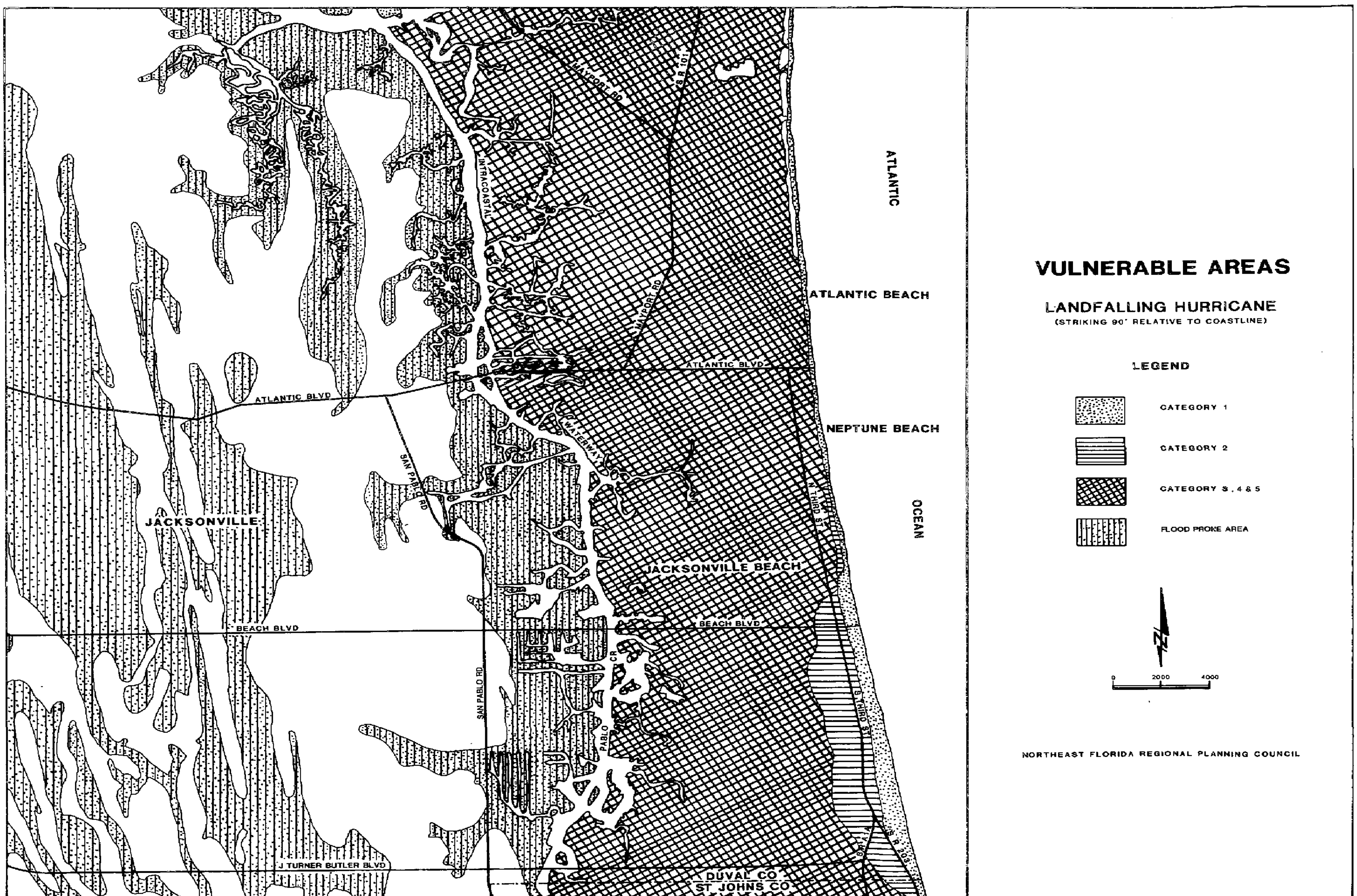
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL

MAP 2

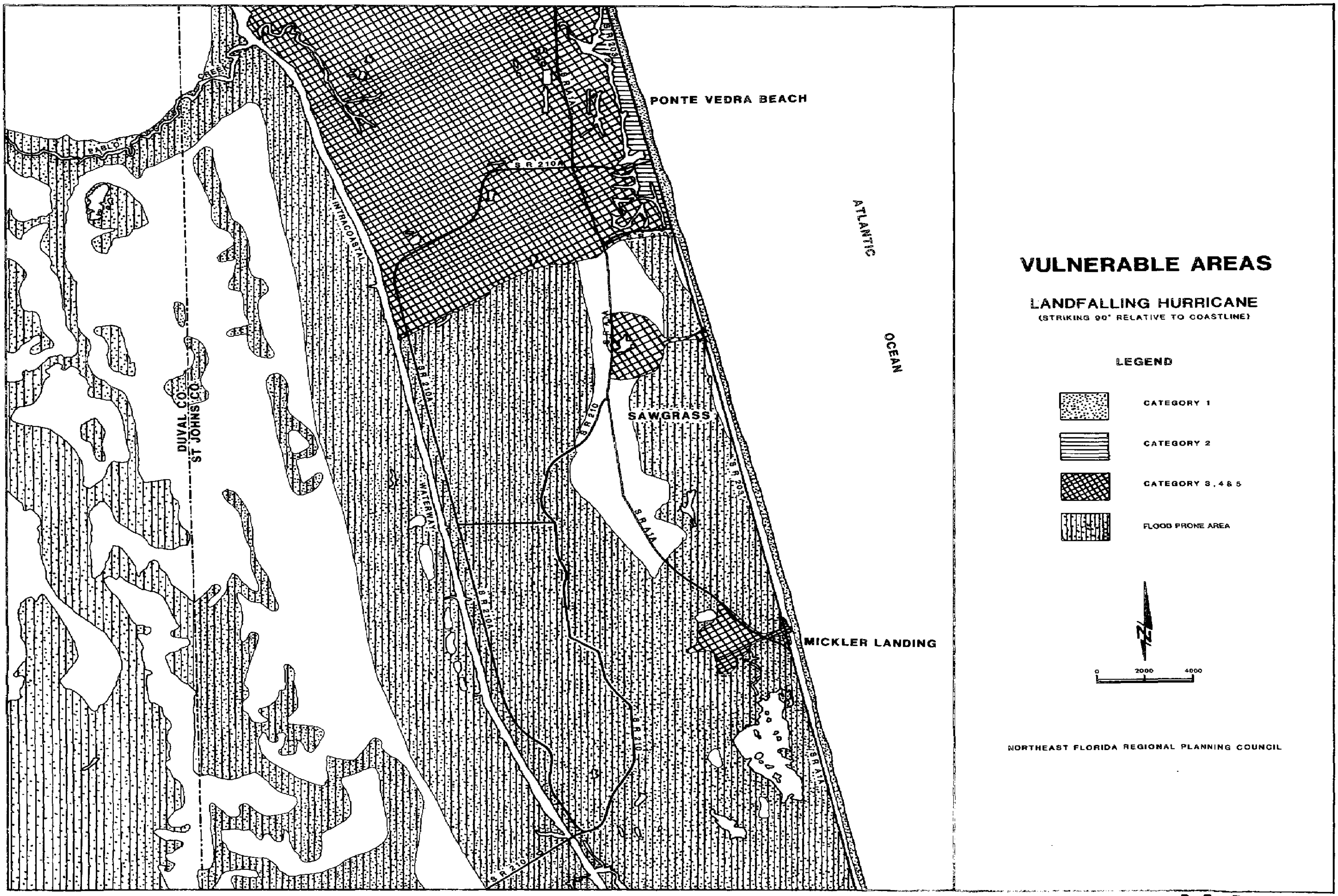


VULNERABLE AREAS
LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)
LEGEND
CATEGORY 1
CATEGORY 2
CATEGORY 3, 4 & 5
FLOOD PRONE AREA
0
2000
4000
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL
ATLANTIC
OCEAN
FORT GEORGE INLET
FORT GEORGE RIVER
FORT GEORGE ISLAND
BUCANEER TRAIL
SAWPIT RD
CEDAR POINT RD
SISTERS CREEK
INTRACOASTAL WATERWAY
HECKSCHER DR
ST JOHNS RIVER
MAYPORT BASIN
MAYPORT NAVAL STATION

MAP 3

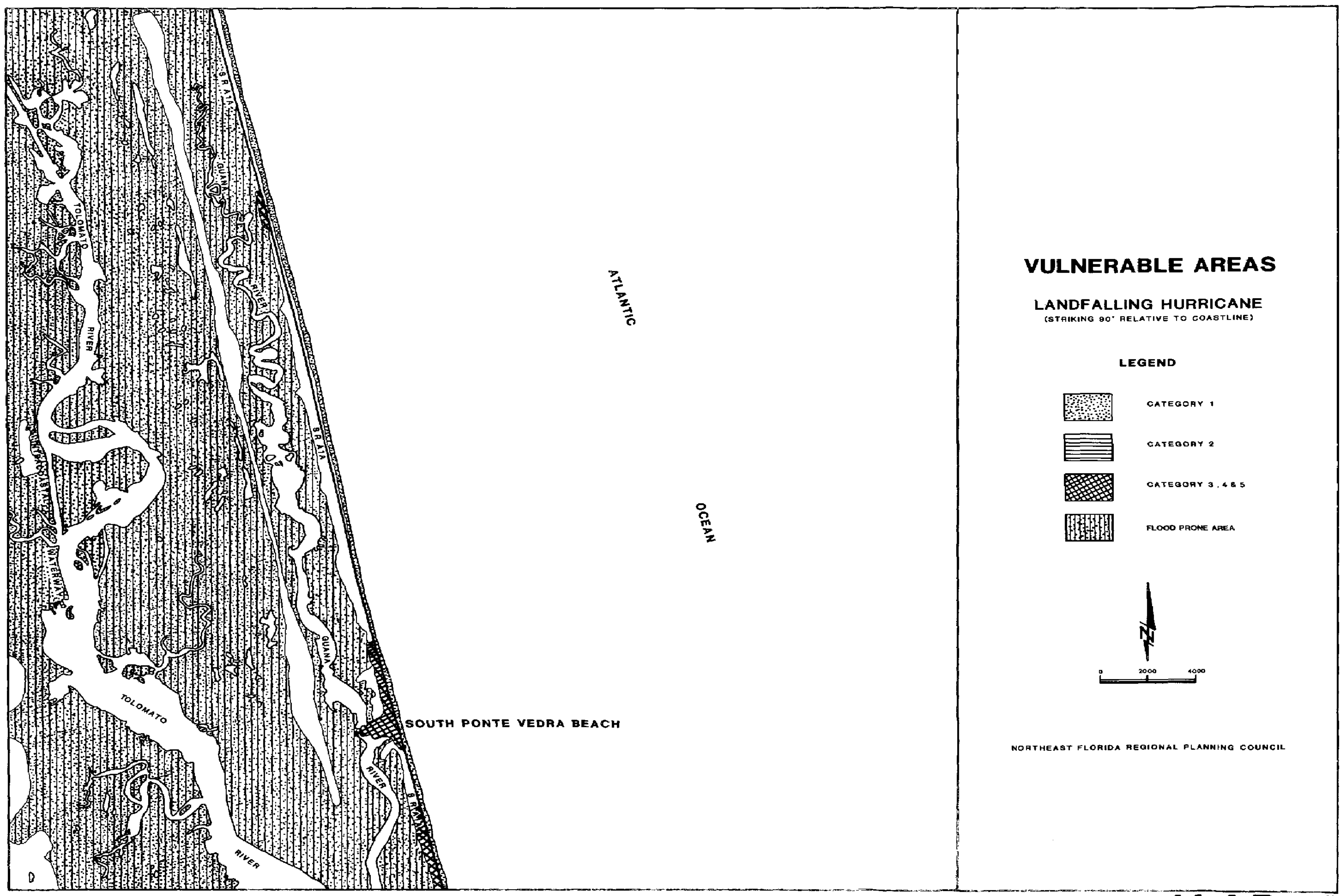

VULNERABLE AREAS
LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)
LEGEND
CATEGORY 1
CATEGORY 2
CATEGORY 3, 4 & 5
FLOOD PRONE AREA
0
2000
4000
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL
ATLANTIC
OCEAN
ATLANTIC BEACH
NEPTUNE BEACH
JACKSONVILLE BEACH
JACKSONVILLE
ATLANTIC BLVD
BEACH BLVD
J TURNER BUTLER BLVD
SAN PABLO RD
INTRACOASTAL
WATERWAY
PABLO
CR
MAYPORT RD
S R 101
N THIRD ST
S THIRD ST
S R 203
DUVAL CO
ST JOHNS CO

MAP 4



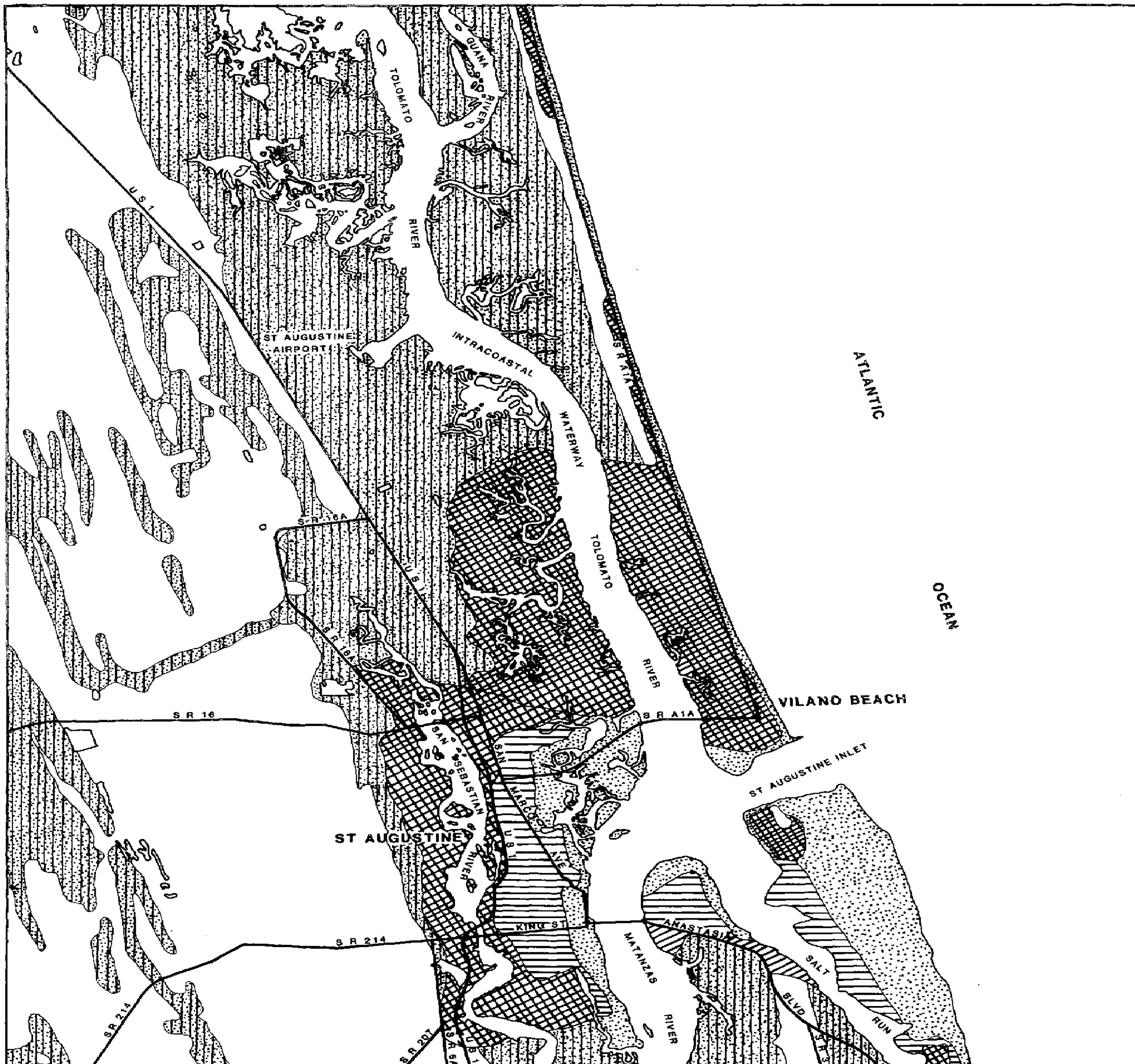
PONTE VEDRA BEACH
SAWGRASS
MICKLER LANDING
DUVAL CO.
ST JOHNS CO.
INTRACOASTAL
WATERWAY
S R 210
S R 210A
S R A1A
S R 203
ATLANTIC
OCEAN
VULNERABLE AREAS
LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)
LEGEND
CATEGORY 1
CATEGORY 2
CATEGORY 3, 4 & 5
FLOOD PRONE AREA
0
2000
4000
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL

MAP 5



VULNERABLE AREAS
LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)
LEGEND
CATEGORY 1
CATEGORY 2
CATEGORY 3, 4 & 5
FLOOD PRONE AREA
N
0
2000
4000
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL
ATLANTIC
OCEAN
SOUTH PONTE VEDRA BEACH
TOLOMATO
RIVER
GUANA
S R A1A
WATERWAY

MAP 6



VULNERABLE AREAS

LANDFALLING HURRICANE

(STRIKING 90° RELATIVE TO COASTLINE)

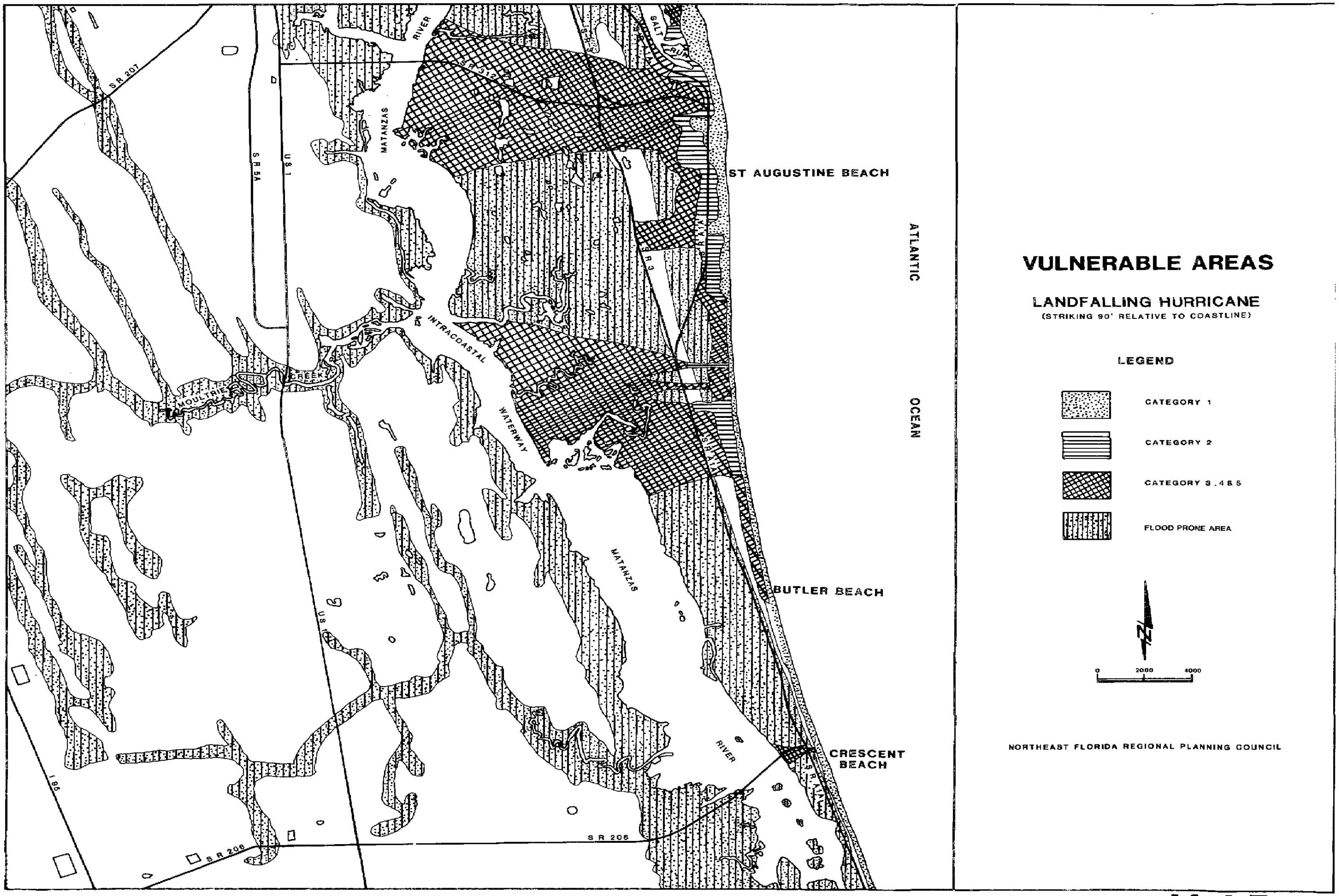
LEGEND

- CATEGORY 1
- CATEGORY 2
- CATEGORY 3, 4 & 5
- FLOOD PRONE AREA

0 2000 4000

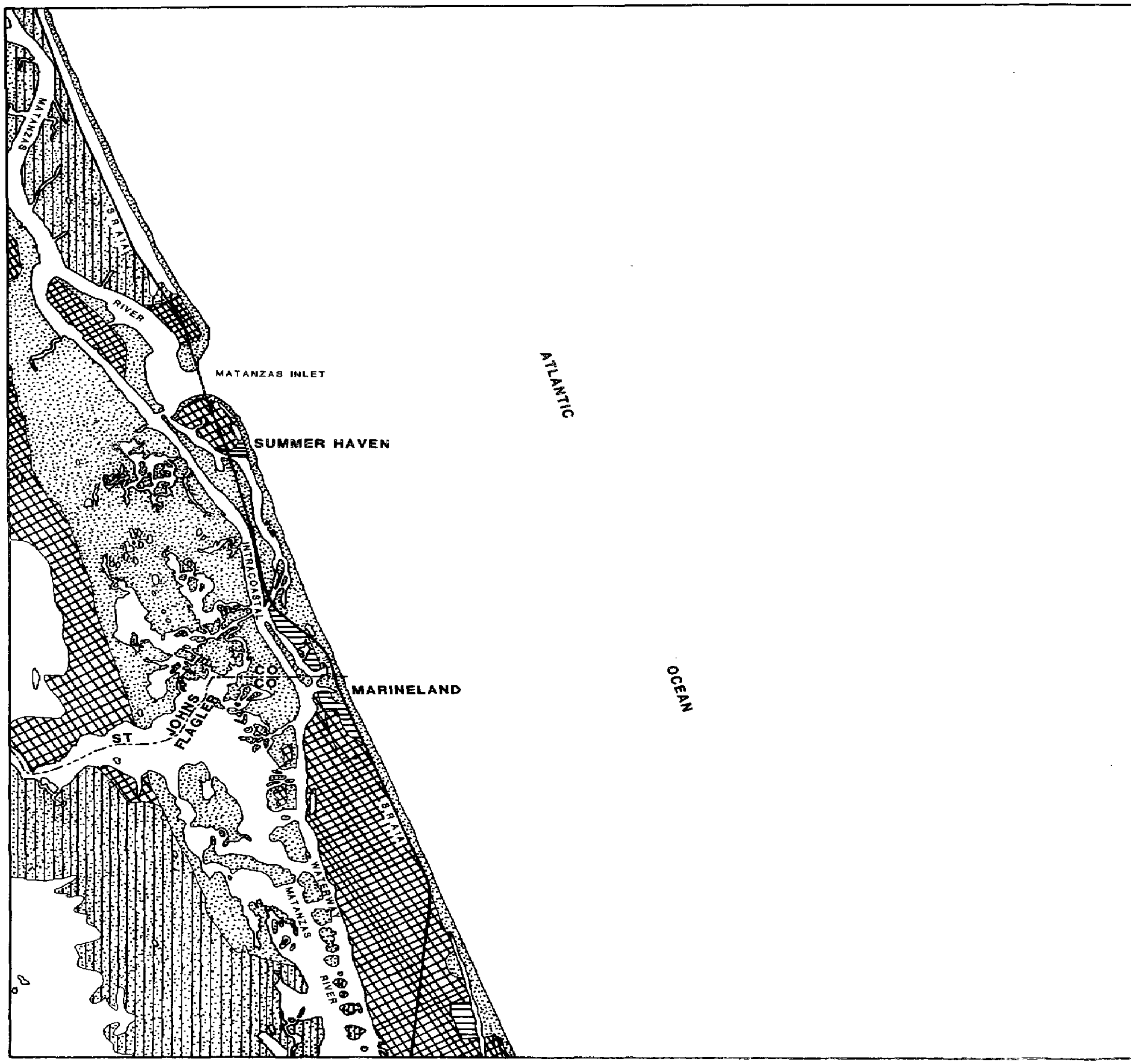
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL

MAP 7



VULNERABLE AREAS
LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)
LEGEND
CATEGORY 1
CATEGORY 2
CATEGORY 3, 4 & 5
FLOOD PRONE AREA
0
2000
4000
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL
ST AUGUSTINE BEACH
BUTLER BEACH
CRESCENT BEACH
ATLANTIC
OCEAN
MATANZAS
RIVER
INTRACOASTAL
WATERWAY
MOULTRIE
CREEK
SALT
S R 207
S R 5A
U S 1
S R 206
I 95
S R 3

MAP 8



VULNERABLE AREAS

LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)

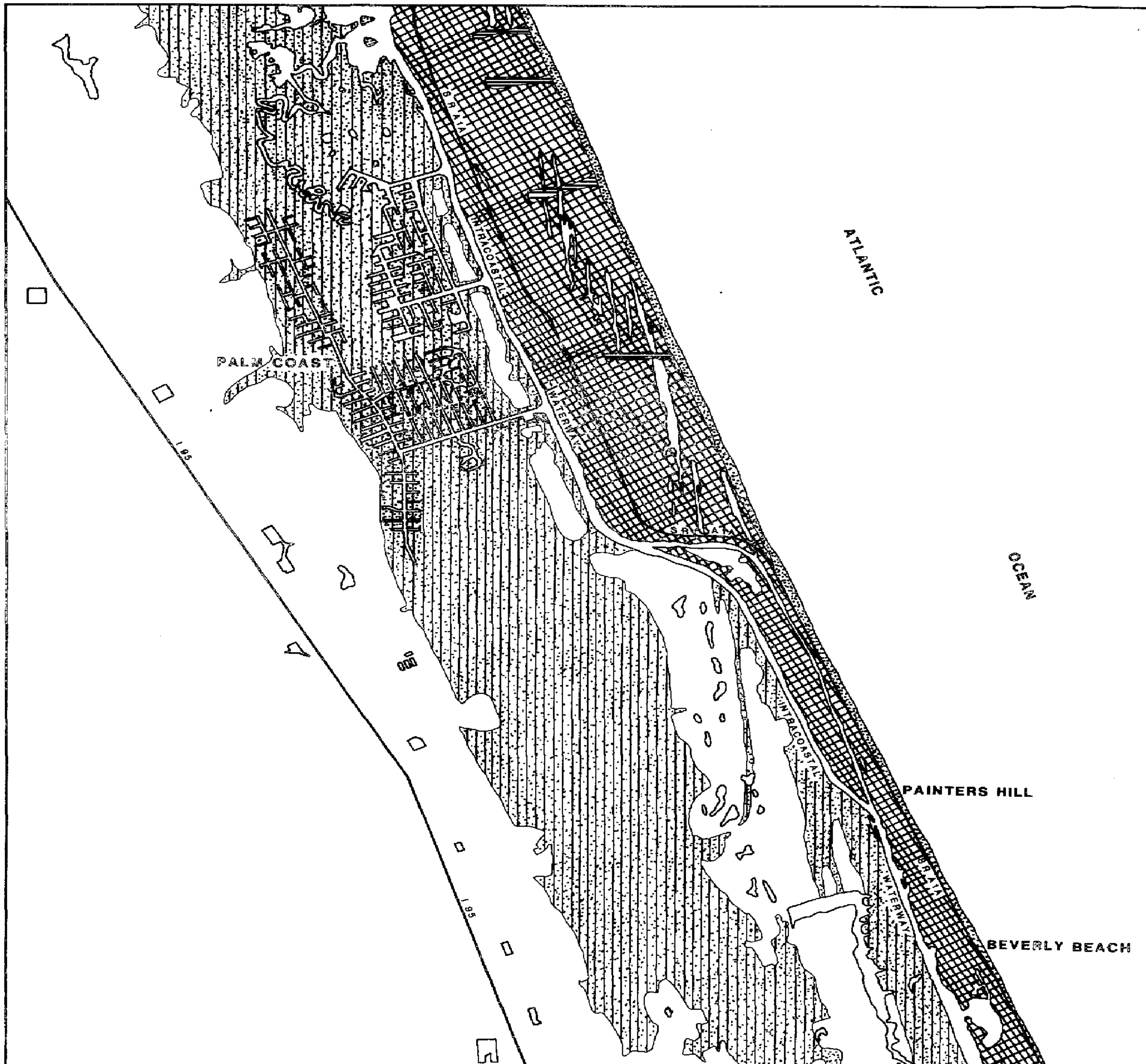
LEGEND

- CATEGORY 1
- CATEGORY 2
- CATEGORY 3, 4 & 5
- FLOOD PRONE AREA

0 2000 4000

NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL

MAP 9



VULNERABLE AREAS

LANDFALLING HURRICANE

(STRIKING 90° RELATIVE TO COASTLINE)

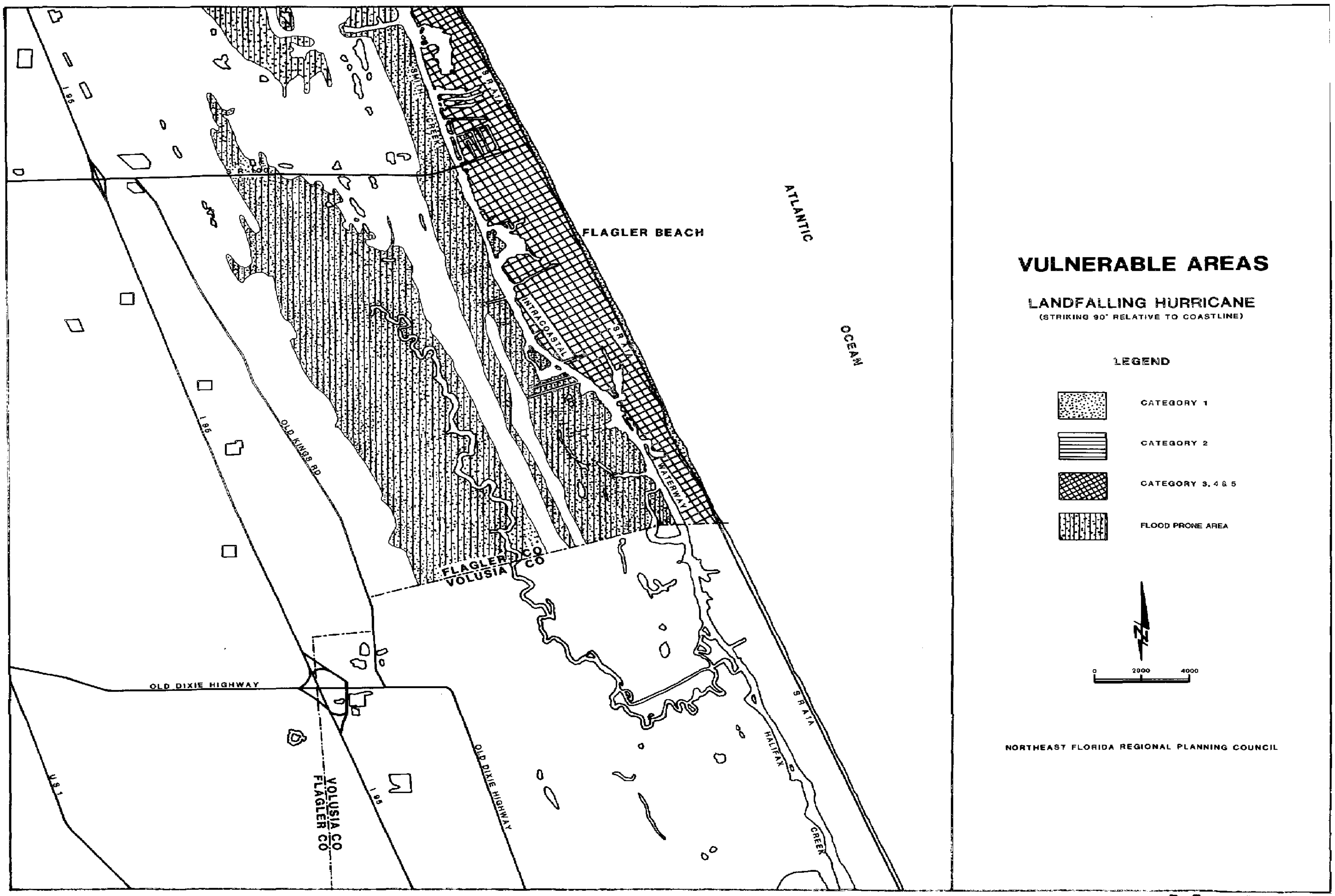
LEGEND

- CATEGORY 1
- CATEGORY 2
- CATEGORY 3, 4 & 5
- FLOOD PRONE AREA

0 2000 4000

NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL

MAP 10


FLAGLER BEACH
ATLANTIC
OCEAN
I 95
OLD KINGS RD
S R 100
SMITH CREEK
S R A1A
INTRACOASTAL
WATERWAY
FLAGLER CO
VOLUSIA CO
OLD DIXIE HIGHWAY
U S 1
HALIFAX CREEK
VULNERABLE AREAS
LANDFALLING HURRICANE
(STRIKING 90° RELATIVE TO COASTLINE)
LEGEND
CATEGORY 1
CATEGORY 2
CATEGORY 3, 4 & 5
FLOOD PRONE AREA
0
2000
4000
NORTHEAST FLORIDA REGIONAL PLANNING COUNCIL

MAP 11

CHAPTER III

POPULATION AND DWELLING UNITS AT RISK

The Vulnerability Analysis included in foregoing Chapter II identified coastal areas which are vulnerable to a hurricane storm-surge. This chapter highlights the threatened population living along the coastline, living in mobile homes, and living in areas threatened by freshwater flooding. Dwelling units at risk are described accordingly.

POPULATION AT RISK

The coastal population at risk in the region is that which is located mainly east of the Intracoastal Waterway. However, those people living along the Intracoastal Waterway, or tributaries thereof, particularly in Duval, St. Johns and Flagler Counties, are also included. For purposes of this Plan, mobile home dwellers at risk include those living west of the Intracoastal Waterway in all seven counties of Northeast Florida. Then too, people living along the St. Johns River and its tributaries must not be overlooked, particularly in view of the history of Hurricane Dora.

Population figures for the coastal area are found in Table 15, whereas figures for mobile home dwellers are in Table 16. See pages 38 and 39.

COASTAL POPULATION-AT-RISK

Nassau County. All residents of Amelia Island, including the City of Fernandina Beach, represent the population at risk in Nassau County. The 1980 census population of 10,840 is estimated to have increased to 13,330 by mid-1983. Of these, some 3,500 people or 26 percent are endangered by the potential surge emanating from a worst case Category V landfalling hurricane. However, the entire population on Amelia Island is endangered by all hurricanes, particularly from their wind effects. All effects (surge, wind, and rain) of hurricanes of all categories moving in any direction will be dangerous to people living along the beachfront, particularly around Atlantic Avenue and north of Atlantic Avenue.

Duval County. The 1983 coastal at-risk population in Duval County is estimated at 45,170. This compares to the 1980 census population of 42,200. In 1980, about three percent of the at-risk population, 1,318 people, lived in the area west of the Intracoastal Waterway and east of Pablo Road. Consequently, 97 percent of the 1983 estimated 45,650 people living on the coast between the ocean and the Intracoastal Waterway will be endangered by a worst case Category V landfalling hurricane. Those living immediately west of the Intracoastal Waterway would be endangered by wind, and rain, and by fresh water flooding emanating from the Intracoastal Waterway. All of the coastal area of Duval County is subject to heavy wind and surge caused by Categories III, IV and V landfalling hurricanes. Hurricanes of all categories will be decidedly dangerous to those residents living close to the beaches as well as in the Mayport fishing village.

St. Johns County. In 1980, 18,760 people lived in the coastal area who were at risk in case of a worst case Category V hurricane. By 1983, growth in these areas raises the estimate of the endangered population to 22,810 people. Those living in the St. Augustine beaches and Matanzas Inlet areas would be endangered due to the runout/aftermath of a surge, particularly from Categories III, IV, and V landfalling hurricanes. However, hurricanes even in the lower categories of I and II, whether landfalling, paralleling, or exiting, will be dangerous to all beach residents. People living in the City of St. Augustine particularly close to the bay front and along the Matanzas River will be confronted with the dangers posed by all categories of hurricanes. The potential for flooding will also endanger residents in low lying areas west of the San Sebastian River.

Flagler County. In 1980, an estimated 4,800 people lived in the zone of danger from the effects of a worst case Category V landfalling hurricane. Of the 4,800, some 1,840, almost 40 percent, were living in the Palm Coast canal areas west of the Intracoastal Waterway. Growth by 1983 results in an estimated 6,190 residents who would be in danger if a worst case Category V hurricane should landfall. Of the 6,190, 2,320 or more live in the Palm Coast canal areas west of the Intracoastal Waterway. The Marineland area would be endangered by all categories of hurricanes. Fortunately, the coastal area elevation along the beach stretching south from Painters Hill to Volusia County is relatively high. Consequently, the City of Flagler Beach could withstand the surge produced by even a Category III worst case landfalling hurricane. That notwithstanding, the wind effects resulting from all categories of hurricanes would endanger all the coastal population, especially those who live in mobile homes.

MOBILE HOME POPULATION-AT-RISK

Mobile homes have become an increasing popular housing type over the past decade due both to more attractive manufactured housing products and the economic effects of heightening construction and land costs, coupled with high mortgage interest rates. In 1970, mobile homes comprised 5.4 percent of the dwelling units in the region. By 1980, this proportion rose to 9.4 percent of the housing stock, a 152 percent increase in units since 1970 (from 11,830 to 29,780 units). This compares to a 38 percent increase in site-built housing in the decade. The trend of growth in the number of mobile homes and increase in their share of the housing stock can be presumed to carry through the 1980's, given continuance of the causal conditions noted above.

Nearly two-thirds, 11,330, of the mobile homes added in the past decade were placed in the four coastal counties, for a 1980 total count to 20,250 mobile homes, of which about 2,800 were located in the coastal at-risk storm surge/flood prone zone. It is estimated that 450 additional mobile homes had been added along the coast by mid-1983. Using a conservative multiplier of 2.0 persons-per-mobile home household, the proportion of mobile home residents in the at-risk population is about 7.4 percent or 6,500 among the 87,980 persons living in the endangered zone in mid-1983.

Because of their susceptibility to high winds, the National Weather Service recommends that all mobile home residents be evacuated to more secure shelter facilities when hurricane force winds are expected. Therefore, the population in mobile homes in the remainder of the Region should be considered an element of the at-risk population. This is estimated at 66,220 mobile home residents outside the coastal at-risk zone in mid-1983, added to the 6,500 within the zone, for a total of 70,720 mobile home residents in the Region.

TABLE 15

COASTAL POPULATION AT RISK

	1980 Census	1983 Estimate
NASSAU	10,840	13,330
DUVAL	42,200	45,650
ST. JOHNS	18,760	22,810
FLAGLER	4,800	6,190
Total Persons	76,600	87,980

COASTAL HOUSING AT RISK

	1980 Census	1983 Estimate
NASSAU	5,230	6,460
DUVAL	16,990	18,510
ST. JOHNS	9,450	11,800
FLAGLER	3,130	3,980
Total Units	34,800	40,750

TABLE 16

MOBILE HOME POPULATION AT RISK
MID-1983

County	In Coastal Risk Zone	Outside Coastal Risk Zone	TOTAL
Baker	-0-	1,960	1,960
Clay	-0-	7,500	7,500
Duval	3,800	26,030	29,830
Flagler	1,140	890	2,030
Nassau	720	7,590	8,310
Putnam	-0-	13,506	13,506
St. Johns	840	6,740	7,580
Region	6,500	66,220	70,720

Source: Northeast Florida Regional Planning Council

Methodology: 1980 Census mobile home count updated by using proportion of mobile homes added per county 1970-1980 in relation to single and multifamily units added, applied to residential construction permits issued per county January 1980 through June 1983. Population estimated at 2.0 persons per mobile home.

CHAPTER IV ROADWAY INUNDATION ANALYSIS

INTRODUCTION

Safe evacuation is predicated upon the movement of vehicles over critically low points on evacuation routes prior to the occurrence of surge induced as well as fresh water induced road blockages. Such blockages can happen prior to the arrival of the eye of a hurricane.

The purpose of this chapter, therefore, is to identify points or segments of low-lying coastal roadways and low bridge approcahes on barrier islands and evacuation routes leading from barrier islands. Such data are needed to determine how soon evacuation would have to be completed prior to roadway inundation by storm surge as well as by flooding (not associated with storm surge).

METHODOLOGY

In conducting the analysis, evacuation routes leading from barrier islands on the coasts of Nassau, Duval, St. Johns, and Flagler Counties were identified. Centerline elevations as available were obtained from microfilm held in files in the Deland and Lake City district offices of Florida's Department of Transportation. Gaps in that data were filled in from spot elevation information taken from storm evacuation maps prepared by the U. S. National Oceanic and Atmospheric Administration, and from quadrangle (contour) maps published by the U. S. Geological Survey. Peak storm surge from the SPLASH II mathematical model (shown in Chapter III) for landfalling hurricanes were compared against the centerline elevations. Furthermore, flood prone data also were compared.

The foregoing data are incorporated in tables 17 through 33 beginning on the next page, which tables are grouped by county, beginning with Nassau. Each table, identified by the respective evacuation route, is broken down by centerline elevations, vulnerability analysis data, and location/distance data.

NASSAU COUNTY

Specific roads and highways on Amelia Island are marked with signs (CD-1) as evacuation routes. For instance, people living on North Fletcher Avenue in an evacuation would travel south to Atlantic Avenue, west on Atlantic Avenue to 14th Street, south on 14th Street to State Road A-1-A, then west on A-1-A across the Intracoastal Waterway and west. Centerline elevations for that particular route are listed in the table which follows.

TABLE 17

NORTH FLETCHER AVENUE - ATLANTIC AVENUE - 14TH STREET - STATE ROAD A-1-A

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
8.00	Cat. 1	North Fletcher Avenue 1 mile N. of Atlantic Avenue
8.86	Cat. 1	3,000 feet N. of Atlantic Avenue
15.75	Cat. 3	Intersection: A-1-A/Fletcher Avenue
19.74	Cat. 4	500 feet W. on Atlantic Avenue
12.75	Cat. 4	1,000 "
5.00	Cat. 4 and Flood Prone	1,500 "
3.67	"	2,000 "
5.79	"	2,500 "
15.70	Cat. 4	3,000 "
26.81		3,500 "
20.80		4,000 "
19.38		4,500 "
19.14		5,000 "
25.67		Intersection: Atlantic Avenue and South 14th
25.00		2,000 feet S. on South 14th Street
25.00		3,000 "
25.00		4,000 "
17.00		7,000 "
16.34		Five Points Intersection/A-1-A
12.63	Flood Prone	On A-1-A, 1,000 feet W. of Five Points Intersection
10.83	"	1,500 feet W. of Five Points Inter.
9.00	"	1,000 feet E. of Shave Bridge
8.00	"	1,500 feet W. of Shave Bridge
9.00	"	2,500 "
13.00		Intersection: A-1-A and County Road 107
20.00		Intersection: A-1-A and Black Rock Road

A second important evacuation route begins at the south end of Amelia Island, extends north on A-1-A to County Road 105A, then continues north along Amelia Island Parkway to A-1-A, left on A-1-A to Shave Bridge and points west. Centerline elevations are summarized on the following page.

Table 18

State Road A-1-A on Amelia Island From South to North

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
8.00	Flood Prone	At S. end of Amelia Island on A-1-A, 3,000 feet N.E. of Nassau Sound bridge.
8.00	"	1½ miles N. of Nassau Sound bridge on A-1-A.
15.00	"	Intersection: A-1-A and Lewis Street
18.00	"	Intersection: A-1-A and Gerbing Road
15.00	"	Intersection: A-1-A and Phillips Manor Road
16.00	"	Intersection: Amelia Island Parkway and Via del Ray
14.00	"	Intersection: Amelia Island Parkway and Amelia Road
10.00	"	Intersection: Amelia Island Parkway and A-1-A

Other connections from the beaches to A-1-A include Sadler Road, which has centerline elevations ranging from 16 to 22 feet, and Bill Melton Drive, which has centerline elevations ranging from an estimated 15 feet to 26 feet. State Road 105 stretching along the seacoast from Atlantic Avenue south to Amelia Island Parkway has centerline elevations ranging from 10 one south of Atlantic Avenue to 25 feet three miles south of Atlantic Avenue. See Storm Surge Inundation Maps 1 and 2 in Chapter II.

Duval County

Major evacuation routes leading from the beaches to points west in Duval County are Hecksher Drive on the north side of the St. Johns River, and Atlantic Boulevard, Beach Boulevard, and J. Turner Butler Boulevard on the south side of the St. Johns River.

Table 19

Hecksher Drive from Fort George Inlet to Broward River

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
7.00	Cat. 1 and Flood Prone	2/5 mile S.W. Fort George Inlet
7.00	"	Ferry entrance
9.00	"	1 mile S.W. ferry entrance
11.00	Cat. 3	1/5 mile S.E. Sisters Creek
6.00	Flood Prone	1 mile W. Sisters Creek
6.00	"	1 mile E. Clapboard Creek
6.00	"	N.W. approach Clapboard Creek
8.00	"	7/10 mile N.W. Clapboard Creek
7.00	"	1.5 mile E. Dunn Creek
3.90	"	E. Approach Dunn Creek
5.80	"	300 feet W. Dunn Creek
3.30	"	900 "
7.60	"	1500 "
3.70	"	2100 "
2.50	"	2700 "
4.80	"	3300 "
6.40	"	3900 "
11.38		E. approach Broward River bridge
11.50		W. approach Broward River bridge
19.00		1 mile W. of Broward River bridge

Table 20

Atlantic Boulevard from 2nd Street to Intracoastal Waterway

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
12.62	Cat. 2	At beaches, 100 ft. E. of 2nd Street
12.65	"	Intersection, 2nd Street
12.77	"	500 feet. W. of 2nd Street
11.82	Cat. 3	1,000 "
10.86	"	1,500 "
11.09	"	2,500 "
10.96	"	2,500 "
11.50	"	3,000 "
12.91	"	3,500 "
12.33	"	4,000 "
9.87	"	4,500
8.18	Cat. 3 and Flood Prone	5,000 (1 mile W. of ocean)
8.67	"	5,500 feet W. of 2nd Street
10.75	Cat. 3	6,000 "
12.45	"	6,500 "
12.86	"	7,000 "
12.44	"	7,500 "
10.60	"	8,000 "
6.83	Cat. 3 and Flood Prone	8,500 "
6.22	"	9,000 "
6.21	"	9,500 "
6.16	"	10,000 "
6.31	"	10,500 "
6.37	"	11,000 "
6.59	"	11,500 "
10.76	"	E. approach to bridge
14.00	"	3,000 feet. w. of Intracoastal Waterway

TABLE 21

BEACH BOULEVARD FROM SEAWALL TO INTRACOASTAL WATERWAY AND WEST

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
12.0	Cat. 2 and Flood Prone	Bulkhead (seawall)
12.8	"	1st Street
11.7	"	400 feet W. of 1st Street
12.2	"	800 "
11.9	"	1,200 "
13.0	"	1,600 "
13.9	Cat. 3	2,000 "
15.4	"	2,500 "
16.6	"	3,000 "
17.1	"	3,500 "
18.3	Cat. 4	4,000 "
18.3	"	4,500 "
19.7	"	5,000 "
19.4	"	5,500 "
16.2	"	6,000 "
10.7	"	6,500 "
8.5	"	7,000 "
7.5	"	7,500 "
7.0	"	3,000 feet E. of Intracoastal Waterway
14.00	"	E. approach to bridge
12.00	"	W. approach to bridge
7.00	Flood Prone	4,000 feet W. of Intracoastal Waterway
11.00	"	1 mile W. of Intracoastal Waterway
18.00	"	1½ miles W. of Intracoastal Waterway

Table 22

J. Turner Butler Boulevard from State Road A-1-A to Pablo Creek

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
11.8	Cat. 3 and Flood Prone	End of ramps at SR A-1-A
27.50		1,000 ft. W. of A-1-A
33.19		2,000 "
16.00	Cat. 5	3,000 "
13.00	"	4,000 "
12.90		5,000 "
13.10	"	6,000 "
11.46	"	7,000 "
12.72	"	8,000
11.86	"	E. approach to Pablo Creek bridge
72.93		Pablo Creek bridge
12.00		W. approach to Pablo Creek bridge

Among connecting routes on the coast south of the St. Johns River are Mayport Road leading from the Mayport Naval Station to Atlantic Boulevard and State Road A-1-A from the Mayport fishing village to Mayport Road.

Table 23

Mayport Road: Mayport Naval Station to Atlantic Boulevard

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
7.20	Cat. 3	Naval Station Gate
7.18	Cat. 5	1,000 feet S. of Gate
7.10	"	Intersection: Mayport Road and Wonderwood Drive
7.04	"	2,000 feet S. of Gate
8.15	"	3,000 "
9.50	"	4,000 "
12.45	"	1 mile S. of Gate
15.47	"	2 miles "
12.95	Cat. 3	3 miles "
12.47	"	Intersection: Mayport Road and Atlantic Boulevard

Only four centerline elevations are available for State Road A-1-A which connects the Mayport Fishing Village with Mayport Road. They are listed as follow:

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
4.38	Cat. 3 and Flood Prone	2,250 feet N. of Sherman Creek
7.00	"	500 feet S. of Sherman Creek
9.00	Cat. 5	Intersection: A-1-A and Wonderwood Drive
15.00	"	Intersection: A-1-A and Mayport Road

State Road A-1-A leading along the coast north from the St. Johns County line to St. Augustine Road at Jacksonville Beach has centerline elevations ranging from 9.6 feet to 11.66 feet. Farther north that same State Road has centerline elevations which are 9 feet one-half mile south of Beach Boulevard, 10 feet one-half mile north of Beach Boulevard, and 12 feet one-half mile south of Atlantic Boulevard. See Storm Surge Inundation Map 4 for vulnerability of this route.

In addition to Hecksher Drive on the north side of the St. Johns River are the roads leading to and from the Black Hammock area, beginning with Sawpit Road. Sawpit Road connects into Cedar Point Road, thence into New Berlin Road. On Sawpit Road, centerline elevations range from 10 to 11 feet. The elevation is 9 feet where Sawpit Road intersects with Cedar Point Road. Centerline elevation on Cedar Point Road 1.2 miles west of the intersection is 10 feet, whereas it is 5 feet three miles west of the intersection (with Sawpit Road). This appears to be the lowest point on that particular evacuation route. Thereafter, centerline elevations on Cedar Point Road range from 11 to 16 feet. Elevations on New Berlin Road into which Cedar Point Road connects are 19 to 20 feet. See Storm Surge Inundation Map 3 for vulnerability analysis.

St. Johns County

The coastal area of St. Johns County is analyzed geographically in three sectors, the north around Ponte Vedra, the central around St. Augustine, and the south around Crescent Beach.

Primary evacuation routes in the northern sector include State Road 210 from State Road A-1-A to the Intracoastal Waterway, and southwest; State Road 210A from A-1-A to the Intracoastal Waterway, and southwest; south on A-1-A; and south on State Road 203. Centerline elevations are summarized in the tables which follow:

TABLE 24

STATE ROAD A-1-A FROM DUVAL COUNTY LINE SOUTH TO STATE ROAD 210

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
12.72	Cat. 3	Duval County Line
16.45	"	1/2 mile S. of Duval County Line
16.25	"	2 miles " " "
15.45		3 miles " " "
14.05	Cat. 5	4 miles " " "
12.76		Intersection with SR 210

TABLE 25

STATE ROAD 210A FROM STATE ROAD A-1-A TO INTRACOASTAL WATERWAY

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
16.00	Cat. 5	Intersection with A-1-A
5.00	Cat. 5 and Flood Prone	2/5 mile W. of SR A-1-A
6.00	" "	1-1/5 mile S.W. of SR A-1-A
7.00	" "	2 miles SW of SR A-1-A
7.00	Flood Prone	4 miles SW of SR A-1-A
8.00	" "	5.5 miles SW of SR A-1-A
6.00	" "	Intersection with SR 210 near bridge

TABLE 26

STATE ROAD 210 FROM SR A-1-A TO INTRACOASTAL WATERWAY

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
12.76	Flood Prone	Intersection with A-1-A
8.00	" "	Palm Valley
8.00	" "	2 miles S. of Palm Valley
6.00	" "	Intersection with SR 210A near bridge

Highest centerline elevation on State Road 203 (which goes between the county line and A-1-A, along the shoreline) is 20 feet. Otherwise, elevations on that particular route generally range from 11 to 13 feet. Centerline elevations on A-1-A from State Road 210 to Vilano Beach range from 8 feet to 21 feet. They are summarized down to South Ponte Vedra Beach on the table which follows:

TABLE 27

STATE ROAD A-1-A FROM 210 TO SOUTH PONTE VEDRA BEACH

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
12.00		Intersection A-1-A and 210
13.00		1½ mile S of 210
11.00	Flood Prone	1 mile S. of Mickler Landing
10.00		3 miles S. of Mickler Landing
9.00		5 miles " " "
16.00		6½ miles " " "
13.00		1½ miles N. of South Ponte Vedra Beach

In the St. Augustine area, the foregoing A-1-A route continues from South Ponte Vedra Beach to Vilano Beach, then across the Vilano Bridge into the City of St. Augustine.

TABLE 28

STATE ROAD A-1-A FROM SOUTH PONTE VEDRA BEACH TO CITY OF ST. AUGUSTINE

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
14.00	Cat. 3	South Ponte Vedra Beach
15.00	"	1½ miles S. of South Ponte Vedra Beach
15.00		3 miles
21.00		3 miles N. of St. Augustine Inlet
13.00	Cat. 3 and Flood Prone	1 mile "
8.00	" "	S. end of Vilano Beach
8.00	" "	Approaches to Vilano Beach
8.00	Cat. 1 and Flood Prone	In City of St. Augustine

Routes inside City of St. Augustine have centerline elevation generally ranging from 5 to 10 feet. The lowest point, five feet, is depicted on King Street about 1,000 feet west of US-1 and also east of the San Sebastian River. Near the fort, Castillo de San Marco, centerline elevation for San Marco Avenue is approximately 7 feet. King Street's elevation is an estimated 8 feet in the area near the County Courthouse. Approaches to the US-1 bridge over the San Sebastian River are 9.7 feet.

Immediately south of the City of St. Augustine, two evacuation routes lead from Anastasia Island. The major route is State Road 312 which connects from St. Augustine Beach directly west to US-1 across the Matanzas River. Centerline elevations for SR-312 are listed as follow:

TABLE 29

STATE ROAD 312 FROM SR A-1-A WEST TO US-1

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
8.00	Cat. 1	Intersection: SR 312/SR A-1-A
10.22	Cat. 5	3,000 feet W. of SR A-1-A
11.50	"	3,500 "
12.71	"	4,000 "
17.33	"	4,500
17.71	"	5,000
17.00	"	Intersection with SR 3
10.00	Cat. 5 and Flood Prone	1,000 feet W. of SR 3
12.66	" " "	3,000 "
11.66	" " "	4,000 "
10.66	" " "	5,000 "
10.66	" " "	7,000 "
11.13	" " "	E. bridge approach
14.10	Flood Prone	W. bridge approach
9.37	" "	2,500 feet E. of US-1
12.95	" "	2,000 feet E. of US-1
16.95		1,500 feet E. of US-1
21.39		Intersection with US-1

The second important route is State Road A-1-A stretching from the intersection of State Raod 3 northwest to the Bridge of Lions. Centerline elevation on Anastasia Island at the limits of the City of St. Augustine is 15.3 feet. At the intersection at SR 3, it is 11 feet. State Road 3 connects with both of these major evacuation routes. Centerline elevations for SR-3 ranges from 11 to 17 feet. Centerline elevations for that stretch of A-1-A leading from SR-3 and hugging the shoreline begins with 7.83 feet one mile south of St. Augustine's city limits, then drops to 6.85 feet at a point near the beach shoreline. Along the beach, centerline elevations range from 7 to 10 feet, then rise to 13 feet where A-1-A reconnects with SR-3 further south. For vulnerability, see **Surge Inundation** Maps 7 and 8.

People living in the southern sector of the coast anywhere along State Road A-1-A south of State Road 3 will be encouraged to drive to State Road 206 then west to US-1. Centerline elevations for State Road 206 range from 7 feet immediately west of the bridge to at least 26 feet at the intersection with US-1. The intersection at State Road A-1-A has an elevation of 8 feet. Centerline elevations for State Road A-1-A beginning at SR-3 and ending at Marineland are listed as follow:

TABLE 30

STATE ROAD A-1-A FROM SR 3 TO MARINELAND

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
13.00	Cat. 5	Intersection: A-1-A and SR-3
8.00	Flood Prone	2 miles N. of Crescent Beach
7.00	"	1½ miles " "
8.00	"	Intersection: A-1-A and SR 206
6.00		2 miles S. of Crescent Beach
8.00	"	1 mile N. of Matanzas Inlet
10.53	Cat. 1 and Flood Prone	N. approach to Matanzas Inlet bridge
9.63	" " "	S. approach " "
8.00	" " "	2 miles S. of Matanzas Inlet
7.38	" " "	Flagler County line

FLAGLER COUNTY

The main evacuation route leading inland from the coast is described as follows:

TABLE 31

STATE ROAD 100 FROM FLAGLER BEACH WEST TO BUNNELL

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
18.57	Cat. 4	Intersection with SR A-1-A
10.68	"	500 feet W. of A-1-A
8.00	"	1,000 "
8.00	"	2,000 "
8.00	"	E. bridge approach
8.00	Flood Prone	W. bridge approach
15.00		2,000 ft. W. of Intracoastal Waterway
13.96		1 mile W. of Intracoastal Waterway
13.00		6,000 feet W. of bridge

TABLE 31

(CONTINUED)

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
12.00	Flood Prone	7,000 feet W. of bridge
17.56		10,000 "
21.44		2 miles W. of Intracoastal Waterway
26.60		" "
27.35		4 " "
28.00		5 " "
27.50		6 " "
23.50		7 " "
20.08		Intersection with US-1

The connecting route from Marineland south on State Road A-1-A to Flagler Beach is described in the following table.

TABLE 32

STATE ROAD A-1-A FROM MARINELAND SOUTH TO SR 100

Centerline Elevations (feet)	Vulnerability Analysis	Location/Distance
7.38	Cat. 1 and Flood Prone	At St. Johns County line
9.19	"	1 mile S. of County line
8.35	Cat. 3	2 "
7.47	"	3 "
8.06	Cat. 4	4 "
10.85	"	5 "
10.97	"	6 "
12.20	"	7 "
15.45	"	8 "
11.68	Cat. 3	9 "
9.50	Cat. 2	10 "
9.41	"	11 "
17.67	Cat. 4	12 "
21.84	Cat. 5	14 "
20.68	"	15 "
18.57	"	Intersection with SR-100

Centerline elevation on State Road A-1-A connecting from the Volusia County line north to Flagler Beach appears to be a constant 19 feet. It would take the surge of a Category 5 landfalling hurricane (striking 90 degrees relative to coastline) to overwhelm this route.

CHAPTER V BEHAVIORAL SURVEY

INTRODUCTION

Equally as important as the hazard analysis, the vulnerability analysis, the roadway inundation analysis, and the delineation of the threatened population and dwelling units, are the behavioral tendencies of the population at risk. It was necessary, therefore, to ascertain the behavioral tendencies of the population at risk 1) to quantify their evacuation time, 2) to determine their region-wide and county-wide demand on roadway capacities, and 3) to develop projections for the number of public shelters which will be required under hurricane-related emergency situations. A survey was conducted during the months of July, August, and September 1983. The following behavioral characteristics were addressed:

- When the threatened population would leave their residences pursuant to an evacuation order;
- The number of vehicles that the threatened households would utilize for evacuation;
- The number of residents who would require public transportation or other assistance if required to evacuate;
- The pre-planned destinations of the population at risk; and
- The general hurricane experience of the population at risk.

METHODOLOGY

As in the process of conducting most surveys, three major components constituted the main underpinnings of the behavioral survey. They were designing of the survey questionnaire, selecting of the survey target areas, and administering of the survey. Then too, the process also included tabulating the responses and analyzing the results.

QUESTIONNAIRE DESIGN

The behavioral survey questionnaire form, a data collection instrument, addressed the major behavioral issues associated with hurricane evacuation. These included evacuation time, vehicle use, special transportation needs, planned destinations and routes, and prior hurricane experience.

A copy of the survey questionnaire form is enclosed as APPENDIX C. Its composition was based on a hybrid of survey questionnaires completed previously by Tampa Bay Regional Planning Council, East Central Florida Regional Planning Council, and Treasure Coast Regional Planning Council.

SURVEY TARGET AREAS

Survey target areas in order of priority were households along the sea coasts of Duval, Flagler, Nassau, and St. Johns Counties; mobile home households in six counties of Northeast Florida; and selected households along banks of the St. Johns River and its tributaries in Clay and Duval Counties.

Of a total 2,000 interviews attempted, 1,588 were completed, from which 1,312 samples were selected based upon completion of the interviews. Of the 1,312 samples, 688 were from among households along the sea coasts of Duval, Flagler, Nassau, and St. Johns Counties. Five hundred fourteen (514) were from mobile home households in the six counties of Clay, Duval, Flagler, Nassau, Putnam, and St. Johns. Those mobile home households targeted in the coastal counties were west of the Intracoastal Waterway. Included in the households on the banks of the St. Johns River and its tributaries were those in Duval County along Heckscher Drive, in Riverside, and in the Venetia/Ortega area. In Clay County, certain households were selected around Doctors Lake, along the St. Johns River, and in the Black Creek area.

As far as possible, the selection of most households was based upon the 1980 Census divisions (of households). For instance, 48 percent of the households east of the Intracoastal Waterway were in Duval County. Accordingly, at least 48 percent of the households targeted in the four county coastal area were in Duval County.

Distribution of Sample

County/Area	Number of Completed Interviews
Nassau County	
Coastal area	49
Mobile homes*	11
Duval County	
Coastal area	432
Heckcher Drive	40
Riverside/Ortega	18
Mobile homes*	199
St. Johns County	
Ponte Vedra Beach	33
Vilano	26
City of St. Augustine	36
St. Augustine Beach and points south	97
Mobile homes*	68

*Located west of the Intracoastal Waterway

Distribution of Sample (continued)

County/Area	Completed Interviews
Flagler Beach	
Coastal area	15
Clay County	
Waterfront	52
Mobile homes	60
Putnam County	
Mobile homes	176

ADMINISTRATION OF SURVEY

Non-profit corporations here in Northeast Florida were contracted to conduct the survey. They did so by telephone from July 1, 1983 to August 31, 1983, using the aforementioned behavioral survey questionnaire form. The non-profit corporations included were: Association for Retarded Citizens, Clay, Inc.; Association for Retarded Citizens of Putnam County, Inc.; Big Brothers and Big Sisters of Nassau County, Inc.; Flagler County Council on Aging, Inc.; Jacksonville League of Woman Voters, Inc.; and St. Johns County Council on Aging, Inc. The Northeast Florida Regional Planning Council assisted volunteers of these corporations in selecting blocks of addresses and telephone numbers and provided them with the survey questionnaires.

Pre-printed postcards were mailed to prospective respondents at least three days in advance of their receiving a telephone call. Volunteers made up to four telephone call backs in attempting to reach those prospective respondents who were not at home.

COMPILATION

Upon completion of the survey, the Northeast Florida Chapter of the American Red Cross was contracted to compile the data and reduce the data onto sheets formatted specifically for analytical purposes. One staff members and a large number of volunteers of that Chapter completed this task in September 1983. The analysis and findings of the Behavioral Survey follow hereafter, first on a county-wide basis, and second on a region-wide basis. In addition, county-wide responses are analyzed in absolute figures.

County-wide Response Analysis

1. Do you live in a:

	Single family home	Apartment	Condominium	Mobile Home	Duplex/Triplex
<u>Nassau County</u>					
Coastal Area	60%	12%	20%		8%
Mobile homes*				100%	
<u>Duval County</u>					
Coastal Area	72%	15%	6%	4%	3%
Hecksher Drive	93%			5%	2%
Riverfront	100%				
Mobile homes*				100%	
<u>St. Johns County</u>					
Ponte Vedra	94%	3%	3%		
Vilano	84%		8%	8%	
St. Augustine	86%	11%		3%	
St. Augustine Beach	84%	6%	4%	5%	1%
Mobile homes*				100%	
<u>Flagler County</u>					
Coastal Area	73%	13%		7%	7%
<u>Clay County</u>					
Riverfront	90%	4%		6%	
Mobile homes				100%	
<u>Putnam County</u>					
Mobile homes*				100%	

*Located west of Intracoastal Waterway

2. If you were ordered by a government authority to evacuate, how soon could you be ready and when would you leave?

	Immediately	One hour	Two hours	Three hours	Four hours plus	Never
<u>Nassau County</u>						
Coastal Area	63%	18%	10%		9%	
Mobile homes *	76%	6%	6%			12%
<u>Duval County</u>						
Coastal Area	64%	18%	9%	4%	2%	3%
Hecksher Drive	80%	10%			2%	8%
Riverfront	72%	22%	6%			
Mobile homes *	70%	18%	3%	3%	3%	3%
<u>St. Johns County</u>						
Ponte Vedra	76%	9%	3%	3%		9%
Vilano	92%					8%
St. Augustine	75%		3%			22%
St. Augustine Beach	53%	14%	14%	6%	2%	11%
Mobile homes *	69%	4%	2%		2%	23%
<u>Flagler County</u>						
Coastal Area	67%	27%				6%
<u>Clay County</u>						
Riverfront	44%	44%	8%		2%	2%
Mobile homes	65%	20%	7%	5%		3%
<u>Putnam County</u>						
Mobile homes	80%	11%	5%		2%	2%

*Located west of Intracoastal Waterway

3. How many people live in your home including yourself?

	One	Two	Three	Four	Five or More
Nassau County					
Coastal Area	18%	39%	22%	15%	6%
Mobile homes*		24%	29%	35%	12%
Duval County					
Coastal Area	17%	38%	22%	16%	7%
Hecksher Drive	8%	55%	20%	15%	2%
Riverfront	5%	56%	22%	17%	
Mobile homes*	17%	38%	22%	16%	7%
St. Johns County					
Ponte Vedra	18%	27%	27%	12%	16%
Vilano	30%	42%	8%	8%	12%
St. Augustine	28%	42%	14%	8%	8%
St. Augustine Beach	18%	46%	19%	10%	7%
Mobile homes*	16%	47%	16%	13%	8%
Flagler County					
Coastal Area	20%	60%	13%	7%	
Clay County					
Riverfront	21%	35%	15%	21%	8%
Mobile homes	8%	38%	20%	15%	19%
Putnam County					
Mobile homes	16%	49%	20%	8%	7%

*Located west of Intracoastal Waterway

4. Do you and members of your family live in the area during months of June through November?

	Yes	No
Nassau County		
Coastal area	88%	12%
Mobile homes*	100%	
Duval County		
Coastal area	99%	1%
Heckscher Drive	100%	
Riverfront	100%	
Mobile homes*	98%	2%
St. Johns County		
Ponte Vedra	97%	3%
Vilano	100%	
St. Augustine	100%	
St. Augustine Beach	97%	3%
Mobile homes *	87%	13%
Flagler County		
Coastal area	93%	7%
Clay County		
Riverfront	100%	
Mobile homes	100%	
Putnam County		
Mobile homes	100%	

*Located west of Intracoastal Waterway

5. Do you and members of your family live in the area during months of December through May?

	Yes	No
Nassau County		
Coastal area	86%	14%
Mobile homes*	100%	
Duval County		
Coastal area	98%	2%
Heckscher Drive	100%	
Riverfront	100%	
Mobile homes*	97%	3%
St. Johns County		
Ponte Vedra	97%	3%
Vilano	96%	4%
St. Augustine	100%	
St. Augustine Beach	94%	6%
Mobile homes*	90%	10%
Flagler County		
Coastal area	93%	7%
Clay County		
Riverfront	100%	
Mobile homes	100%	
Putnam County		
Mobile homes	100%	

*Located west of Intracoastal Waterway

6. How many vehicles are in your household?

	One	Two	Three	Four plus
Nassau County				
Coastal area	35%	51%	14%	
Mobile homes *	37%	46%	12%	5%
Duval County				
Coastal area	38%	42%	12%	8%
Heckscher Drive	15%	56%	20%	9%
Riverfront	22%	72%	6%	
Mobile homes *	36%	47%	12%	5%
St. Johns County				
Ponte Vedra	24%	48%	18%	10%
Vilano	46%	31%	8%	15%
St. Augustine	55%	24%	10%	11%
St. Augustine Beach	43%	40%	11%	6%
Mobile homes *	46%	37%	12%	5%
Flagler County				
Coastal area	46%	39%	11%	4%
Clay County				
Riverfront	23%	40%	27%	6%
Mobile homes	28%	48%	17%	7%
Putnam County				
Mobile homes	37%	46%	11%	6%

*Located west of Intracoastal Waterway

6A. How many vehicles would you use during an evacuation?

	One	Two	Three	Four plus
Nassau County				
Coastal area	67%	25%	5%	3%
Mobile homes *	80%	20%		
Duval County				
Coastal area	66%	26%	5%	3%
Heckscher Drive	55%	42%	3%	
Riverfront	61%	39%		
Mobile homes *	69%	24%	5%	2%
St. Johns County				
Ponte Vedra	67%	30%	3%	
Vilano	83%	13%		4%
St. Augustine	78%	14%	4%	4%
St. Augustine Beach	68%	22%	7%	3%
Mobile homes *	75%	17%	6%	2%
Flagler County				
Coastal area	67%	25%	5%	3%
Clay County				
Riverfront	63%	25%	10%	
Mobile homes	78%	21%	1%	
Putnam County				
Mobile homes	72%	24%	4%	

*Located west of Intracoastal Waterway

6B. Would you need transportation such as a bus or taxi?

	Yes	No
Nassau County		
Coastal area	4%	96%
Mobile homes *		100%
Duval County		
Coastal area	5%	95%
Heckscher Drive		100%
Riverfront		100%
Mobile homes*	4%	96%
St. Johns County		
Ponte Vedra		100%
Vilano		100%
St. Augustine	11%	89%
St. Augustine Beach	1%	99%
Mobile homes*		100%
Flagler County		
Coastal area	14%	86%
Clay County		
Riverfront	4%	96%
Mobile homes		100%
Putnam County		
Mobile homes	4%	96%

*Located west of Intracoastal Waterway

7. Is there anyone who could not be evacuated without help from outside your home?

	Yes	No
Nassau County		
Coastal area	2%	98%
Mobile homes *	7%	92%
Duval County		
Coastal area	4%	96%
Heckscher Drive	5%	95%
Riverfront		100%
Mobile homes *	4%	96%
St. Johns County		
Ponte Vedra		100%
Vilano	4%	96%
St. Augustine	11%	89%
St. Augustine Beach	3%	97%
Mobile homes*	2%	98%
Flagler County		
Coastal area		100%
Clay County		
Riverfront	6%	94%
Mobile homes		100%
Putnam County		
Mobile homes	8%	92%

*Located west of Intracoastal Waterway

8. After leaving your home, where would you go?

	Designated Red Cross Shelter	Friend or Relative	Hotel or Motel	Don't Know
Nassau County				
Coastal area	16%	53%	27%	4%
Mobile homes*	20%	47%	20%	13%
Duval County				
Coastal area	22%	51%	20%	7%
Heckscher Drive	11%	55%	18%	16%
Riverfront	39%	50%	11%	
Mobile homes*	46%	37%	12%	5%
St. Johns County				
Ponte Vedra	26%	45%	29%	
Vilano	17%	44%	22%	17%
St. Augustine	41%	35%	14%	10%
St. Augustine Beach	24%	46%	15%	15%
Mobile homes*	67%	23%	6%	4%
Flagler County				
Coastal area	60%		13%	27%
Clay County				
Riverfront	36%	36%	8%	20%
Mobile homes	43%	33%	3%	21%
Putnam County				
Mobile homes	53%	28%	7%	12%

* Located west of Intracoastal Waterway

9. What route would you take? What major highway or street?

Nassau County - coastal area

A-1-A west	96%
Unspecified	4%

Duval County - coastal area

Atlantic Boulevard	36%
J. Turner Butler Boulevard	28%
Beach Boulevard	36%

Duval County - Heckscher Drive/Talbot Island

Heckscher Drive	100%

St. Johns County - Ponte Vedra

J. Turner Butler	85%
A-1-A	3%
State Road 210	9%
Unspecified	3%

St. Johns County - Vilano Beach/South Ponte Vedra

A-1-A south	83%
A-1-A north	4%
Unspecified	13%

St. Johns County - Anastasia/Davis Shores

Bridge of Lions	24%
State Road 312	19%
US-1	9%
Unspecified	48%

St. Johns County - St. Augustine Beach/Crescent Beach

Bridge of Lions	3%
State Road 312	52%
State Road 206	21%
Other	7%
Unspecified	17%

Flagler County - coastal area

State Road 100 - 100%

10. Have you ever experienced a direct hurricane strike?

	Yes	No
Nassau County		
Coastal area	49%	51%
Mobile homes*	59%	41%
Duval County		
Coastal area	67%	33%
Heckscher Drive	63%	37%
Riverfront	83%	17%
Mobile homes*	60%	40%
St. Johns County		
Ponte Vedra	58%	42%
Vilano	73%	27%
St. Augustine	81%	19%
St. Augustine Beach	75%	25%
Mobile homes*	89%	11%
Flagler County		
Coastal area	67%	33%
Clay County		
Riverfront	65%	35%
Mobile homes	63%	37%
Putnam County		
Mobile homes	53%	47%

*Located west of Intracoastal Waterway

11. Into which age group do you belong?

	35 and under	35-49	50-64	65 and over
Nassau County				
Coastal area	22%	33%	33%	12%
Mobile homes*	18%	53%	24%	5%
Duval County				
Coastal area	31%	26%	25%	18%
Heckscher Drive	18%	20%	50%	12%
Riverfront	6%	28%	44%	22%
Mobile homes*	34%	30%	21%	15%
St. Johns County				
Ponte Vedra	30%	36%	18%	16%
Vilano	11%	19%	35%	35%
St. Augustine	14%	17%	19%	50%
St. Augustine Beach	15%	20%	35%	30%
Mobile homes*	16%	12%	44%	28%
Flagler County				
Coastal area		20%	27%	53%
Clay County				
Riverfront	19%	33%	31%	17%
Mobile homes	34%	28%	25%	13%
Putnam County				
Mobile homes	13%	19%	37%	31%

*Located west of Intracoastal Waterway

Region-wide Response Analysis

1. Do you live in a:

	Regionwide (total selected responses)	Coastal homes
Single family home	48% (646)	76% (522)
Apartment	6% (87)	12% (82)
Condominium	3% (44)	6% (42)
Mobile home	42% (568)	4% (26)
Duplex or triplex	1% (20)	2% (16)
	100% (1,365)	100% (688)

2. If you were ordered by a government authority to evacuate, how soon could you be ready and when would you leave?

	Regionwide	Coastal Homes	Mobile homes *
Immediately	68%	65%	73%
One hour	17%	17%	14%
Two hours	6%	9%	4%
Three hours	3%	3%	2%
Four hours plus	1%	1%	1%
Never	5%	5%	6%
	100%	100%	100%

3. How many people live in your home including yourself?

	Regionwide	Coastal	Mobile homes*
One	17%	18%	15%
Two	41%	40%	43%
Three	21%	21%	21%
Four	14%	14%	13%
Five plus	7%	7%	8%
	100%	100%	100%

* West of the Intracoastal Waterway

4. Do you and members of your household live in the area during months of June through November?

	Yes	No
Regionwide	98%	2%
Coastal	98%	2%
Mobile homes*	97%	2%

5. Do you and members of your household live in the area during months of December through May?

	Yes	No
Regionwide	97%	3%
Coastal	98%	2%
Mobile homes*	97%	3%

6. How many vehicles are in your household?

	Regionwide	Coastal	Mobile Homes *
One	46%	38%	37%
Two	39%	42%	46%
Three	11%	12%	12%
Four plus	4%	8%	5%
	100%	100%	100%

6A. How many vehicles would you use during an evacuation?

	Regionwide	Coastal	Mobile Homes *
One	67%	65%	72%
Two	25%	26%	23%
Three	5%	6%	3%
Four plus	3%	3%	2%
	100%	100%	100%

*West of Intracoastal Waterway

6B. Would you need transportation such as a bus or taxi?

	Yes	No
Regionwide	4%	96%
Coastal	4%	96%
Mobile homes *	3%	97%

7. Is there anybody who could not be evacuated without help from outside your home?

	Yes	No
Regionwide	4%	96%
Coastal	4%	96%
Mobile homes *	5%	95%

8. After leaving your home, where would you go?

	Regionwide	Coastal	Mobile Homes *
Designated Red Cross Shelter	33%	22%	49%
Friend or relative	42%	47%	31%
Hotel or motel	15%	19%	8%
Don't know	10%	12%	12%
	100%	100%	100%

9. What route would you take? What major highway or street?

See county-wide analysis.

10. Have you ever experienced a direct hurricane strike?

	Yes	No
Regionwide	64%	36%
Coastal	67%	33%
Mobile homes *	59%	41%

* West of Intracoastal Waterway

11. Into which age group do you belong?

	Regionwide homes	Coastal homes	Mobile homes*
35 and under	34%	26%	24%
35 - 49	25%	26%	24%
50 - 64	30%	27%	30%
65 and over	21%	21%	22%
	100%	100%	100%

* West of Intracoastal Waterway

Key Response Analysis - Absolute Figures

2. If you were ordered by a government authority to evacuate, how soon could you be ready and when would you leave?

	Immediately	One Hour	Two Hours	Three Hours	Four Hours+	Never
Nassau County						
Coastal area	8,398	2,399	1,333		1,200	
Mobile homes*	5,768	455	455			912
Duval County						
Coastal area	29,216	8,217	4,109	1,826	912	1,370
Heckscher Drive	280	35			7	28
Mobile homes*	18,221	4,685	781	781	781	781
St. Johns County						
Ponte Vedra	3,741	443	148	148		443
Vilano	1,588					138
St. Augustine	8,978		359			2,633
St. Augustine Beach	2,221	587	587	251	84	461
Mobile homes*	4,651	270	139		139	1,550
Flagler County						
Coastal area	2,667	1,075				238
Clay County						
Riverfront	4,875	1,500	525	375		225
Mobile homes						
Putnam County						
Mobile homes	10,805	1,486	675		270	270

* Located west of Intracoastal Waterway

6. How many vehicles are in your household?

	Households	Vehicles			
		One	Two	Three +	Total
Nassau County					
Coastal area	6,460	2,262(1)	3,295(2)	904(3)	11,563
Mobile homes*	3,795	1,404 (1)	1,746 (2)	455 (3)	5,806
Duval County					
Coastal area	18,510	7,043(1)	7,774(2)	3,702(3)	33,697
Heckscher Dr.	140	21(1)	78(2)	41(3)	300
Mobile homes*	13,015	4,685(1)	6,117(2)	2,213(3)	23,558
St. Johns County					
Ponte Vedra	2,784	668(1)	1,337(2)	779(3)	5,679
Vilano	897	412(1)	278(2)	207(3)	1,589
St. Augustine	5,806	3,194(1)	1,393(2)	1,219(3)	9,637
St. Augustine Beach	2,313	995(1)	925(2)	393(3)	4,024
Mobile homes *	3,370	1,550(1)	1,247(2)	573(3)	5,763
Flagler County					
Coastal area	3,980	1,821(1)	1,552(2)	597(3)	6,727
Clay County					
Mobile homes	3,750	1,050(1)	1,800(2)	901(3)	7,353
Putnam County					
Mobile homes	6,753	2,499(1)	3,107(2)	1,147(3)	12,154

* West of Intracoastal Waterway

6A. How many vehicles would you use during an evacuation?

	Households Evacuating	Vehicles			
		One	Two	Three +	Total
Nassau County					
Coastal area	6,460	4,328(1)	1,615(2)	517(3)	9,109
Mobile homes*	3,339	2,671(1)	668(2)		4,007
Duval County					
Coastal area	17,955	11,850(1)	4,668(2)	1,487(3)	25,647
Heckscher Dr.	130	72(1)	55(2)	3(3)	191
Mobile homes*	12,624	8,711(1)	3,030(2)	883(3)	17,420
St. Johns County					
Ponte Vedra	2,533	1,697(1)	760(2)	76(3)	3,445
Vilano	825	685(1)	107(2)	33(3)	998
St. Augustine	4,529	3,533(1)	634(2)	362(3)	5,887
St. Augustine Beach	2,059	1,400(1)	453(2)	206(3)	2,924
Mobile homes*	2,595	1,946(1)	441(2)	208(3)	3,452
Flagler County					
Coastal area	3,741	2,506(1)	935(2)	299(3)	5,273
Clay County					
Mobile homes	3,637	2,838(1)	764(2)	35(3)	4,471
Putnam County					
Mobile homes	6,618	4,765(1)	1,588(2)	265(3)	8,736

*West of Intracoastal Waterway

6B. Would you need transportation such as a bus or taxi?

	Evacuating Population	Yes
Nassau County		
Coastal area	13,330	4% or 533
Mobile homes *	6,678	-0-
Duval County		
Coastal area	44,280	5% or 2,214
Heckscher Dr.	322	-0-
Mobile homes *	25,249	4% or 1,010
St. Johns County		
Ponte Vedra	4,480	-0-
Vilano	1,450	-0-
St. Augustine	9,337	11% or 1,027
St. Augustine Beach	3,730	1% or 37
Mobile homes *	5,119	-0-
Flagler County		
Coastal area	5,819	14% or 815
Clay County		
Mobile homes	7,275	4% or 291
Putnam County		
Mobile homes	13,236	4% or 529

* West of Intracoastal Waterway

7. Is there anyone who could not be evacuated without help from outside your home?

	Evacuating Population	Yes
Nassau County		
Coastal area	13,330	2% or 266
Mobile homes*	6,678	7% or 467
Duval County		
Coastal area	44,280	4% or 1,771
Heckscher Dr.	322	5% or 16
Mobile homes*	25,249	4% or 1,010
St. Johns County		
Ponte Vedra	4,480	-0-
Vilano	1,450	4% or 58
St. Augustine	9,337	11% or 1,027
St. Augustine Beach	3,730	3% or 112
Mobile homes*	5,119	2% or 102
Flagler County		
Coastal area	5,819	-0-
Clay County		
Mobile homes	7,275	-0-
Putnam County		
Mobile homes	13,236	8% or 1,059

* West of Intracoastal Waterway

8. After leaving your home, where would you go?

	Evacuating Population	Designated Red Cross Shelter	Friend or Relative	Hotel or Motel	Don't Know
Nassau County					
Coastal area	13,300	2,133	7,065	3,599	533
Mobile homes*	6,678	1,336	3,138	1,336	868
Duval County					
Coastal area	44,280	9,742	22,583	8,856	3,099
Heckscher Dr.	322	35	177	58	52
Mobile homes*	25,249	11,615	9,342	3,030	1,262
St. Johns County					
Ponte Vedra	4,480	1,165	2,016	1,299	
Vilano	1,450	247	638	319	246
St. Augustine	9,337	3,828	3,268	1,307	934
St. Augustine Beach	3,730	895	1,715	560	560
Mobile homes*	5,119	3,430	1,177	307	205
Flagler County					
Coastal area	5,819	3,492		756	1,571
Clay County					
Mobile homes	7,275	3,128	2,401	218	1,528
Putnam County					
Mobile homes	13,236	7,016	3,706	926	1,588

* West of Intracoastal Waterway

8.b.c. After leaving, where would you go?

To a friend or relative; in what county or city would that be?

From	To	
Nassau County	Nassau County-inland	28% or 2,858
	Duval County	13% or 1,326
	Georgia	44% or 4,489
	Alachua County	3% or 306
	Other cities, counties, or states	6% or 612
	Unspecified	6% or 612
Duval County	Duval County-inland	74% or 23,731
	Clay County	5% or 1,603
	Alachua County	2% or 641
	Georgia	7% or 2,245
	Other cities	7% or 2,245
	Other states	3% or 962
	Unspecified	2% or 641
St. Johns County-Ponte Vedra Beach	Duval County-inland	86% or 1,734
	Orange Park	7% or 141
	Other cities in State	7% or 141
St. Johns County (excluding Ponte Vedra Beach)	St. Johns County-inland	30% or 2,038
	St. Augustine	13% or 884
	Duval County	17% or 1,156
	Alachua County	10% or 680
	Putnam County	9% or 612
	Other cities	13% or 884
	Other states	3% or 204
	Unspecified	5% or 340
Clay County (mobile homes)	Clay County	47% or 1,129
	Duval County	32% or 768
	Other cities in State	16% or 384
	Georgia	5% or 120
Putnam County (mobile homes)	Putnam County	54% or 2,002
	Duval County	6% or 222
	Georgia	17% or 630
	Alachua County	5% or 185
	Other cities in state	18% or 667

8.d.e. After leaving, where would you go? To a hotel or motel; in what county or city would that be?

From	To	
Nassau County	Nassau County-inland	33% or 1,630
	Duval County	27% or 1,332
	Georgia	27% or 1,332
	Alachua County	7% or 345
	Unspecified	6% or 296
Duval County	Duval County-inland	77% or 9,193
	Georgia	18% or 2,149
	Other cities	5% or 597
St. Johns County-Ponte Vedra Beach	Duval County-inland	78% or 1,013
	Clay County	11% or 143
	Not specified	11% or 143
St. Johns County (excluding Ponte Vedra Beach)	St. Johns County-inland	51% or 1,271
	St. Augustine	30% or 748
	Other cities	19% or 474
Flagler County	Putnam County	50% or 243
	Other cities	50% or 243
Clay County (mobile homes)	Clay County	100% or 218
Putnam County (mobile homes)	Putnam County	51% or 471
	Lake City	14% or 130
	Alachua County	7% or 65
	Georgia	7% or 65
	Other states	7% or 65
	Unspecified	14% or 130

FINDINGS

Survey data generated and analyzed further reveals findings which are conveniently categorized around certain ones of the behavioral survey questions as follow:

1. Findings Based on Question 1: Type of Housing Unit

   Household type is a key variable for predicting automobile ownership and use, and sheltering demand. All mobile homes, for instance, should be evacuated during an evacuation. As noted in the Region-wide Analysis, 42 percent of all respondents live in a mobile home. Counties of Northeast Florida have a relatively high percentage of mobile homes. Then too, a significant portion of the region's population live along the sea coast, most of whom should be evacuated.

2. Findings Based on Question 2: Evacuation Order Responses

   On a region-wide basis, 68 percent of all respondents stated they will evacuate immediately. Sixty-five (65) percent of respondents of coastal households will evacuate immediately, which is the same percentage revealed in a similar survey conducted among coastal residents of Brevard and Volusia Counties in 1982 by the North Central Regional Planning Council.

   A larger percentage of people living in mobile homes located inland will evacuate immediately as compared to those living in all types of housing units on the coast, at least from a regional perspective. St. Johns County is the exception. It is noteworthy in St. Johns County that a significant 23 percent of the respondents living in mobile homes answered "never" to Question 2. Additionally, a large number of the respondents living in the City of St. Augustine also answered they would never evacuate (as revealed in the County-wide Response Analysis).

3. Findings Based on Question 3: Household Characteristics - Persons Per Household

   On a region-wide basis, a higher percentage of single people live on the coast. The average size of families among mobile home households appears larger. This is true indeed in Clay and Nassau Counties, as shown in Question 3 of the County-wide Response Analysis.

   More of the coastal residents would be inclined to stay with a relative or friend. Flagler County is a major exception, at least according to the County-wide Analysis. It is suggested that due to rapid growth in that county, fewer coastal residents have family or other social ties with those residents who live inland.

4. Findings Based on Questions 4 and 5: Year-Round Residency

Answers to Questions 4 and 5 indicate that only a small percentage of permanent residents leave the area during hurricane season (June through November) as well as during the period December through May. On a county-wide basis, however, a significant number of people living on the coast in Nassau County and in mobile homes in St. Johns County leave these areas during the hurricane season. Answers to Question 5 also show that a significant number of coastal residents of Nassau County and mobile home residents of St. Johns County also leave during the period December through May.

5. Findings Based on Questions 6, 6A, and 6B: Vehicle Availability and Usage

It is critical to have a realistic estimate of the number of vehicles which will enter the evacuation route network. According to the region-wide response analysis, a large majority of households have at least two vehicles. On a region-wide basis, the ratio of cars to households is 1.8:1, which happens to be the same for the coastal areas at risk. Also on a region-wide basis, 70 percent of all registered vehicles would be utilized in an evacuation which is estimated to be at least 92,000. The percentage ranges, however, from 60 percent among mobile households in St. Johns County to 79 percent among coastal households in Nassau County. Although the majority of avacuees would utilize only one vehicle, at least 25 percent (of the evacuees) from respective households would travel in two vehicles, as shown in the region-wide response analysis. However, the use of two or more vehicles varies from county to county, as noted in the county-wide response analysis. On a region-wide basis, most residents would not rely upon a bus or taxi. The coastal area of Flagler County and City of St. Augustine are the exceptions, as seen in the county-wide response analysis.

6. Findings Based on Question 7: Transportation Disadvantaged or Handicapped

The region-wide response analysis shows that four to five percent of the respondents would need transportation. Applied on a region-wide basis, this means that an estimated 5,888 people would need transportation assistance. The assumption is that most would need the assistance of non-profit corporations such as respective county councils on aging, associations for retarded citizens, etc. Hence, the elderly and physically and mentally handicapped would be prime examples of the people in need of transportation. It is noteworthy that the City of St. Augustine has a significant percentage of such people in need, as reflected in the county-wide response analysis.

7. Findings Based on Questions 8 and 9: Evacuation Destinations and Routes

Evacuation destinations and routes are significant for determining the distance and period of time necessary for completion of evacuation, the demand on evacuation routes, and the demand for shelter space.

As shown in the Region-wide Response Analysis, almost half of the residents living inland in mobile homes would travel to a designated Red Cross Shelter, compared to only 22 percent of the respondents who live on the coast.

Attention is drawn to the responses to Question 9 of the County-wide Response Analysis. A substantial number of coastal residents living in St. Johns County gave no answer or did not know which route to take in the event of a evacuation. It is noteworthy that most people in Ponte Vedra Beach would travel into Duval County, then west on J. Turner Butler Boulevard. Furthermore, most of those from Ponte Vedra seeking designated Red Cross shelters would do so in Duval County.

8. It was necessary to determine if the population-at-risk have a true perception of or previous experience with hurricanes and to further determine if their perception will affect future hurricane preparedness and evacuation efforts.

   On a region-wide basis, 67 percent of the coastal residents answered "yes" to their having experienced a direct hurricane strike. It was found in the analysis, however, that many residents felt they had been affected by Hurricane David, which paralleled off shore and which furthermore was not a major storm. Unfortunately, a sizeable portion of the people who will be at-risk in the event of a hurricane landfalling believe they have encountered a hurricane without having to evacuate. Consequently, in the future they may be reluctant to evacuate.

COMPARATIVE ANALYSIS

Other hurricane hazard and evacuation plan studies have been completed in Florida and have incorporated behavioral studies. Several have already been referenced in this chapter. For comparative purposes, some of these studies are examined inasmuch as many of the questions included herein were in fact included in them.

Briefly, in the way of background, the first hurricane evacuation plan with corresponding behavioral survey in Florida was the Lee County Flood Emergency Evacuation Plan completed in 1979 by the U. S. Corps of Engineers. That survey was subsequently used as a base for developing the behavioral survey as part of the Tampa Bay Flood Emergency Evacuation Plan. The "domino principal" prevailed as similar surveys were completed as integral parts of hurricane evacuation plans in the Sanibel-Captiva area, in Southwest Florida, in the Treasure Coast coastal area, in the Southeast Florida coastal area, and in the East Central Florida coastal area, all in that order. Respective regional planning councils completed all but the Southeast Florida coastal area survey; most behavioral surveys were done on a contractual basis. The Southeast Florida plan was completed by the Corps of Engineers, even though contracted to Post, Buckley, Schuh & Jernigan, Inc.

Table 33 on page 85 constitutes a comparative analysis based upon specific questions which were included in the behavioral surveys of three hurricane evacuation plans, namely those completed by the East Central Florida Regional Planning Council, the Tampa Bay Regional Planning Council, and the Corps of Engineers (for the Southeast Florida hurricane evacuation plan). All of the aforementioned surveys were based on the Lee County prototype; the similarity in questions facilitated comparative analysis.

As noted in Table 33 , the study completed in the Southeast Florida area showed a significant 26 percent people responding that they would never evacuate; this quotient was attributed to the fact that the Southeast Florida study included a number of residents not residing in vulnerable or at-risk areas. Otherwise, all of the surveys completed in at-risk areas revealed that in excess of 90 percent of the residents (in those areas) would evacuate if ordered to do so. As stated heretofore, a quotient of 65 percent was identical for coastal residents of East Central Florida (Brevard and Volusia Counties) and of Northeast Florida regarding "Immediate" as their answer concerning evacuation.

In all surveys, vehicle usage ranged from sixty to eighty percent, the average being seventy percent. The high 82 percent usage rate found in the East Central Florida inland area is attributed to the large number of one-vehicle households (in that study area).

As noted particularly in the coastal areas of East Central Florida and Northeast Florida, the demand for shelter space was lowest. Those living in coastal areas generally are affluent. Hence, many would seek a friend or relative or a hotel or motel as opposed to seeking a public shelter.

Although there is no specific research on how quickly groups have responded to evacuation orders in the past, certain delay factors have appeared. Specifically, residents have taken time after the order to seek confirmation of the danger through additional sources, including neighbors, friends and relatives.

Finally, for those persons who say they will not evacuate, the only viable alternative for public officials at this time is to further educate them. There is no documented case in the country in which such persons have been forcibly removed from their homes. Political reasons, tradition, the danger to enforcement officials, and the need for these officials in other pursuits have precluded such action.

TABLE 33

COMPARATIVE ANALYSIS OF SELECTED BEHAVIORAL SURVEYS

	Northeast Florida Coastal	Northeast Florida Inland	East Central Florida Coastal	East Central Florida Inland	Tampa Bay	Southeast Florida
EVACUATION RESPONSE						
Immediate	65%	73%	65%	81%	77%	69%
Certain Number of Hours	30%	21%	27%	15%	17%	5%
Never	5%	6%	8%	4%	6%	26%
VEHICULAR USAGE	73%	69%	70%	82%	71%	70%
NEED FOR SPECIAL HELP	4%	5%	4%	7%	3%	N.A.
DESTINATION						
Shelter	22%	49%	18%	46%	38%	23%
Friend or Relative	47%	31%	38%	18%	26%	28%
Hotel or Motel	19%	8%	31%	15%	19%	10%
Don't Know	12%	12%	13%	21%	17%	11%

CHAPTER VI

PUBLIC SHELTERING INVENTORY AND DEMAND

INTRODUCTION

Due to efforts of American Red Cross chapters, county school boards, and civil defense directors, a number of school buildings in the Northeast Florida region have been designated as public shelters in the event of a hurricane striking. Therefore, the examination of shelter preparedness is vital to local disaster preparedness officials inasmuch as the data so generated determines the adequacy of existing shelters and the need for additional shelters. Accordingly, this chapter includes 1) an inventory of shelters broken down by county, 2) an analysis of the capability of the shelters to meet demand, and 3) a shelter/medical surge analysis to determine the vulnerability of hospitals and nursing homes located on the coast.

SHELTER INVENTORY

Civil Defense Directors, American Red Cross personnel, and county school board administrators were cooperative in providing valuable information needed for the inventory and assisted in the required data collection.

Tables 34 through 40 beginning on the following page constitute the inventory. Shelters in coastal counties of Nassau, Duval, St. Johns and Flagler are inventoried first, in that order, followed by those in Clay, Putnam and Baker. In each table, information is broken down by shelter location, capacity, shelter manager, and shelter facilities. Facilities are further detailed to determine the availability of emergency power; whether water and sewer systems are independent, or dependent upon city or county; the availability of food facilities and stocked food; and the vulnerability of each shelter in regard to the hazards related to storm surge. Shelter capacity is based upon 20 square feet per person.

SHELTER DEMAND AND AVAILABILITY

Sheltering demand in the six counties of Northeast Florida and the capabilities of the shelters to accommodate prospective evacuees are summarized in Table 41 on page 105. As noted in the footnote at the bottom of Table 41, figures showing the population seeking shelter are taken from Chapter V, the Behavioral Survey. The figures reflect a "worse case" condition resulting from a landfalling Category 3 hurricane (striking 90 degrees relative to the coastline) in which all coastal residents as well as all mobile home residents in all counties are endangered and hence are ordered to evacuate. (Continued on page 105)

TABLE 34

SHELTER INVENTORY - NASSAU COUNTY

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Bryceville Elementary P. O. Box 3 Church Avenue Bryceville 266-9241	68	June Page	No		X	X		Unknown	
Callahan Elementary 100 South Booth Street Callahan 879-2121	326	Blanco Lee	No	X		X	X	15 min.	
Callahan Intermediate Rt. 2 Box 283 State Road 108 Callahan 879-1114	156	Glenn Long	Yes		X	No		20	
Callahan Junior High P. O. Box AA Rd 115 Callahan 879-3606	1417	Ben Rice	No	X		X	X	23	
West Nassau High 300 South Brown Street Callahan 879-3461	666	Emmitt Coakley	No	X		X	X	15 min.	
Emma Love Hardee Elementary 300 Susan Drive Fernandina Beach 261-5507	275	James Davis	No	X		X	X	15	
Fernandina Beach High 515 Citrona Avenue Fernandina Beach 261-5713	522	William Fryer	No	X		X	X	19	

TABLE 34

SHELTER INVENTORY - NASSAU COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Fernandina Beach Junior High Atlantic Avenue Fernandina Beach 261-4461	592	Eugene Grant	No	X		X	X	25	
Southside Elementary 1112 Jasmine Street Fernandina Beach 261-5509	1046	Mildred Campbell	No	X		X	X	20	
Hilliard Elementary P. O. Box 1109 First Street Hilliard 845-4471	156	Carl Kane	No	X		No	No	20 min.	
Hilliard Junior-Senior High P. O. Box 1199 First Street Hilliard 845-2171	588	Ada Revell	No	X		X	X	20 min.	
Yulee Elementary P. O. Box 57 US 17 Yulee 225-5116	491	Robert Springer	No		X	X	X	20 min.	
Yulee Junior High P. O. Box 68 State Road 200 and A1A Yulee 225-5192	795	Ray Davis	No		X	X	X	20 min.	

TABLE 35

SHELTER INVENTORY - DUVAL COUNTY

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Brentwood Elementary 3750 Springfield Avenue 355-7875	114	Cynthia Anderson	No	X		X	X	20	
Ruth Upson Elementary 1090 Dancy Street 389-3253	180	Raymond Williams	Yes	X		X	X	20	
Fishweir Elementary 3977 Herschel Street 389-2230		Beverly Morrison	Yes	X		X	X	15	
John Gorrie Junior High 2525 College Street 384-1391	248	Jerry Gugel	No	X		X	X	20	
Corinne Scott Elementary 1951 Market Street 354-0831	123	Walter White	No	X		No	No	20	
Loretto Elementary 3900 Loretto Road 268-5722	175	Josie Doty	No		X	X	X	30	
Landon Junior High 1831 Thacker Avenue 396-1457	270	Jerry Jackson	No	X		X	X	10	
Robert E. Lee Senior High 1200 S. McDuff Avenue 388-3778	515	Ray Stasco	No	X		No	No	20	

TABLE 35

SHELTER INVENTORY - DUVAL COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Andrew Jackson Senior High 23816 Main Street 633-6475	594	Donald Buckley	No	X		No	No	20	
Baldwin Junior-Senior High 291 Mill Street Baldwin 266-4461	375	Ted Starnes	No	X		X	X	30	
Dinsmore Elementary 7126 Civic Club Road 765-2700	128	Michael Akers	No	X		X	X	10	
Thomas Jefferson Elementary 8233 Nevada Street 781-5566	132	Margaret McCaughey	Yes		X	X	X	65	
Whitehouse Elementary 11160 General Avenue 781-5977	141	Lucille Coberly	No		X	X	X	75	
Garden City Elementary 2814 Dunn Avenue 764-6900	146	Donna Sutton	No		X	X	X	20	
Oceanway 7th Grade Center 143 Florida Avenue 757-1464	382	Carlotta Ray	Yes	X		X	X	30	
Hogan-Spring Glen Elementary 6736 Beach Boulevard 725-1044	200	Elizabeth Scudder	Yes	X		X	X	15	

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TABLE 35

SHELTER INVENTORY - DUVAL COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER Depend.	WATER/SEWER Independ.	FOOD Kitchen	FOOD Stocked	Vulnerability Analysis Elevation (feet)	Vulnerability Analysis Flood Hazard
DuPont Junior High 2710 DuPont Avenue 737-2060	270	Bill English	No	X		X	X	20	
Lake Shore Junior High 2519 Bayview Avenue 389-1152	386	Chester Silas	Yes	X		No	No	20	
North Shore Elementary 5701 Silver Plaza 764-7561	378	Hortense Brewington	No	X		X	X	20	
Hendricks Avenue Elementary 3400 Hendricks Avenue 396-3319	99	Juanita Wilson	No	X		X	X	20	
John Love Elementary 1531 Winthrop Street 355-1238	146	John Gornto	Yes	X		X	X	15	
Paxon Senior High 3239 West Fifth Street 786-2910	515	B. J. Ford	Yes	X		X	X	20	
Ramona Elementary 5540 Ramona Boulevard 786-0606	272	Mildred Pittman	Yes	X		X	X	25	
Love Grove Elementary 2446 University Boulevard South 724-8351	170	R. L. Hutcheson	Yes	X		X	X	20	

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TABLE 35

SHELTER INVENTORY - DUVAL COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
San Jose Elementary 5805 St. Augustine Road 733-9600	182	Janis Bourne	Yes	X		X	X	40	
Lake Lucina Elementary 6527 Merrill Road 744-6777	269	Susan Heavener	No	X		X	X	40	
Terry Parker Senior High 7301 Parker School Road 724-8100	816	Ralph Patterson	Yes		X	X	X	40	
John Stockton Elementary 4827 Carlisle Road 384-2111	182	Nancy Snyder	Yes	X		X	X	10	
Woodland Acres Elementary 328 Bowlan Street 724-5788	140	James Aderhold	No	X		X	X	45	
Englewood Senior High 4412 Barnes Road 733-1770	515	Harold Pearman	Yes	X		X	X	15	
Pinedale Elementary 4229 Edison Avenue 389-0601	151	Jewel Israel	No	X		X	X	25	
Windy Hills Elementary 3831 Forest Boulevard 641-1686	144	Verna Fields	Yes	X		X	X	50	

TABLE 35

SHELTER INVENTORY - DUVAL COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Ribault Senior High 3701 Winton Drive 633-5197	598	Walter Harris	Yes	X		X	X	15	
Timucuan Elementary 5429 110th Street 771-1125	112	Jane Condon	Yes	X		X	X	15	
Highlands Elementary 1000 DePaul Drive 751-0323	150	Carolyn Chambliss	Yes.	X		X	X	20	
Douglas Anderson 7th Grade Cen. 2425 San Diego Road 396-7038	384	Judy Poppell	Yes	X		X	X	25	
Susie Tolbert Elementary 1925 West 13th Street 354-6013	140	Llewllyn Sadler	Yes	X		X	X	25	
Mathew Gilbert 7th Grade Cen. 1424 Franklin Street 633-4357	200	Curtis Randolph	Yes	X		X	X	15	
Stanton College Preparatory 1149 West 13th Street 633-3394	916	Carole Walker	Yes	X		X	X	25	
Northwestern Junior High 2100 West 45th Street 633-6062	695	Quentin Messer	Yes	X		X	X	25	

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TABLE 35

SHELTER INVENTORY - DUVAL COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Carver Elementary 2854 West 45th Street 765-1323	122	Estelle McKissick	Yes	X		X	X	20	
Butler 7th Grade Center 900 Acorn Street 633-3410	342	Herman Howard	Yes	X		X	X	25	
Reynolds Lane Elementary 840 Reynolds Lane 388-3410	162	Carolyn Carl	Yes	X		X	X	25	
Pickett Elementary 6305 Old Kings Road 786-1655	162	Lloyd Daniel	Yes	X		X	X	15	
Brookview Elementary 10450 Theresa Drive 641-9033	148	Dorethea Haynes	Yes	X		X	X	35	
Stuart Senior High 4815 Wesconnett Boulevard 771-5050	242	Rex Marchman	Yes	X		X	X	15	
Davis Junior High 7050 Melvin Road 771-5050	400	Veronica Valentine	Yes	X		X	X	60	
Stilwell Junior High 7840 Burma Road 781-6260	578	Cecil Allison	No	X		X	X	60	

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TABLE 35

SHELTER INVENTORY - DUVAL COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Wolfson Senior High 7000 Powers Avenue 733-6260	503	David White	Yes						
Jacksonville Heights Elementary 7750 Tempest Street South 771-8011	131	Jane Patterson	Yes	X		X	X	80	
Beauclerc Elementary 4555 Craven Road West 733-1055	150	Donna Darby	No	X		X	X	15	
Lone Star Elementary 10400 Lone Star Road 642-4510	154	Paula Potter	No	X		X	X	50	
Stonewall Jackson Elementary 6127 Cedar Hills Boulevard 771-9590	150	Sandra Davis	Yes	X		X	X	20	
Sandalwood Junior-Senior High 2750 John Prom Boulevard 641-1020	1362	Linda Lewis	Yes	X		X	X	40	
Ft. Caroline Junior High 3787 University Club Boulevard 744-1911	572	Jim Jaxon	Yes	X		X	X	40	
Arlington Heights Elementary 1520 Sprinkle Drive 744-7900	155	Dorothy Overmier	Yes	X		X	X	40	

TABLE 35

SHELTER INVENTORY - DUVAL COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Forrest Senior High 5 530 Lanier Road 757-3143	808	Ron Poppell	Yes	X		X	X	55	
Sheffield Elementary 13333 Lanier Road 757-3143	125	Irving Huffingham	Yes	X		X	X	30	
Crown Point Elementary 3800 Crown Point Road 2262-0960	220	Mildred Logan	Yes	X		X	X	15	
White Senior High 1700 Old Middleburg Road 786-4020	497	John Thombleson	Yes	X		X	X	30	

TABLE 36

SHELTER INVENTORY - ST. JOHNS COUNTY

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
St. Augustine Technical Center Collins Avenue at Del Monte Dr. St. Augustine 824-4401	1,335	Steve Hand	Yes	X		X	X	15 min.	
Ketterlinus Junior High (upper floor) 75 Orange Street St. Augustine 824-4431	528	Bobbie Braden	No	X	Artesian Well	X	X	7 min.	Cat 2 storm surge
Webster Sixth Grade Center 146 Orange Street St. Augustine 824-2955	80	Roger Coffee	No	X		X	X	35 feet	
W. Douglas Hartley Elementary 260 Riviera St. Augustine Shores 797-7156	184	Dolores Rowley	Yes		X	X	X	30	
Mill Creek Elementary State Road 16 St. Augustine 829-3537	86	Gary Blount	No		X	X	X	25	
Hastings Elementary Boulevard South Hastings 692-1154	64	Steve Moranda	No	X	Artesian Well	X	X	7	
Julington Creek Elementary 2316 Racetrack Road N.W. sector of county 268-2311	1,573	Susan Yocius	No	X		X	X	15 min.	

TABLE 36

SHELTER INVENTORY - ST. JOHNS COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER Depend.	WATER/SEWER Independ.	FOOD Kitchen	FOOD Stocked	Vulnerability Analysis Elevation (feet)	Vulnerability Analysis Flood Hazard
Allen Nease Junior-Senior High Ray Road N. sector of county 824-1234	274	Halver Stedman	No		X	X	X	60	
Murray Junior High Holmes Boulevard St. Augustine 824-1234	80	Jim Smeland	No	X		X	X	35	

Table 37

Shelter Inventory - Flagler County

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Flagler-Palm Coast High E. of Bunnell Route 100 E. 437-2474	2,030	Darrell Furguson	No	X		X	X	25	
Bunnell Elementary Howe Street Bunnell 437-2171	1,546	Nancy Willis	No	X		X	X	25	
Belle Terre Middle School Belle Terre Parkway Palm Coast 445-4172	2,334	E.L. "Buddy" Taylor	Yes	X		X	X	29	

TABLE 38

SHELTER INVENTORY - CLAY COUNTY

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Orange Park High 2300 Kingsley Avenue Orange Park 272-8100	652	Jim Booth	No	X		X	X	65	
Grove Park Elementary 1643 Miller Street Orange Park 272-8140	172	Ed Paulk	No	X		X	X	15	
Lakeside Middle School 2750 Moody Road Orange Park 272-8135	248	Bill Knowles	No	X		X	X	65	
Montclair Elementary 2752 Moody Road Orange Park 272-8125	156	Don Thompson	No	X		X	X	27	
Orange Park Middle School 1500 Gano Avenue Orange Park 272-8145	232	Thomas Moore	No	X		X	X	65	
S. Bryan Jennings Elementary 215 Corona Drive Orange Park 272-8165	218	Sara Reese	No	X		X	X	55	
Lakeside Elementary 2752 Moody Road Orange Park 272-8135	192	Carol Broxton	No	X		No	No	65	

TABLE 38

SHELTER INVENTORY - CLAY COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Orange Park Elementary Plainfield & Stiles Orange Park 272-8155	112	Donald Sohm	No	X		X	X	18	
Doctors Inlet Elementary P. O. Box 66 Doctors Inlet 272-0557	147	William Turner	No		X	X	X	11	
J. L. Wilkinson Elementary State Road 218 Middleburg 282-5494	232	Millie Wilkes	No		X	X	X	25	
Middleburg High School 3802 State Road 220 Middleburg 282-9325	602	Ira Strickland	Yes		X	X	X	22	
Middleburg Elementary P. O. Box 148 Middleburg 282-4611	134	Twila Shrewsburg	No	X		X	X	20	
Green Cove Springs Elementary P. O. Box 308 Green Cove Springs 284-3376	540	Jim Gainey	No	X		X	X	15	
Bennett Elementary Rt. 2 Box 295 Green Cove Springs	178	Ray Jenner	No	X		X	X	20	

TABLE 38

SHELTER INVENTORY - CLAY COUNTY (CONTINUED)

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER Depend.	WATER/SEWER Independ.	FOOD Kitchen	FOOD Stocked	Vulnerability Analysis Elevation (feet)	Vulnerability Analysis Flood Hazard
Clay High School P. O. Box 608 Green Cove Springs 284-6530	602	Gerald Guswiler	No	X		No	No	50	
Keystone Heights Junior-High P. O. Box 706 Keystone Heights 473-2761	384	David Owens	No	X		X	X	140	
Keystone Heights Elementary P. O. Box 1207 Keystone Heights 473-4844	154	Hubert White	No	X		No	No	150	

TABLE 39

SHELTER INVENTORY - PUTNAM COUNTY

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Mosley Elementary School 1100 Husson Avenue Palatka 328-3012	430	James Holt	No	X		X	X	75	
Kelley Smith Elementary 2 blocks S. of SR-20 Francis 325-3029	1,072	Lee Shiver	No		X	X	X	75	
Jenkins Middle School North 19 Street Palatka 325-4085	399	Phil Alvers	No	X		X	X	15	
Crescent City High US-17 Crescent City 325-3810	2,332	Joel Hull	Yes		X	X	X	20	
Melrose Community School Off State Road 26 Melrose 328-5763	767	Doug Grant	No		X	X	X	100	
Interlachen High School Off State Road 20 Interlachen 328-3638	2,332	Chelsea Merritt	Yes	Water	Sewage Disposal	X	X	100	

TABLE 40

SHELTER INVENTORY - BAKER COUNTY

SHELTER (Address/Phone)	CAPACITY	MANAGER	EMERGENCY GENERATOR	WATER/SEWER		FOOD		Vulnerability Analysis	
				Depend.	Independ.	Kitchen	Stocked	Elevation (feet)	Flood Hazard
Baker County High East Jonathan Street Macclenny 259-6286	1500	Ronnie Davis	No	X		X	X	Unknown	
Westside Elementary Madison Street Glen St. Mary 259-3330	1000	Jerry Sisk	No	X		X	X	Unknown	

Availability rate percentages in Table 41 show a shortage of sheltering space in St. Johns County. In that county, a special committee consisting of school board administrative personnel, the Civil Defense Director, and American Red Cross personnel are aware of the shortage. They are resolved to find and designate additional shelters by June 1984, the beginning of hurricane season.

Table 35, Shelter Inventory-Duval County, does not list consolidated City of Jacksonville public buildings which also are available for shelters. Further, the Northeast Florida Chapter of American Red Cross is seeking additional shelters (as of February 1984); the Chapter is in a negotiating stage with a number of churches and other privately-owned organizations in Duval County.

TABLE 41

SHELTER DEMAND AND AVAILABILITY

COUNTY	POPULATION* SEEKING SHELTER	SHELTER** CAPACITY	SHELTER AVAILABILITY RATE
Nassau	3,469	7,098	100%
Duval	22,557***	24,661****	100%
St. Johns	8,400	4,202	50%
Flagler	3,492	5,910	100%
Clay	3,128	4,955	100%
Putnam	7,016	7,332	100%

*Based upon figures shown in Chapter V, Behavioral Survey; see page 78.

**Figures taken from sheltering inventory; based upon 20 square feet per person.

***Includes 1,165 evacuees from Ponte Vedra Beach area.

****Includes 5,975 spaces in public buildings owned by the Consolidated City of Jacksonville

HOSPITALS AND NURSING HOMES

In the beaches areas of three of the four coastal counties, Nassau, Duval, and St. Johns, hospitals and nursing homes have been contacted to determine if they have local evacuation plans. Flagler County, the exception, has no hospitals or nursing homes on its coastal area.

Nassau County. Storm surge emanating from a Category 4 landfalling hurricane (striking 90 degrees relative to the coastline) would endanger Amelia Island Care Center. The Center, which is located on 2700 Atlantic Avenue, is situated 19 feet above mean sea level. The Center has an evacuation plan; by agreement, the Center's clients would be moved to Arlington Manor Care Center in Jacksonville.

Duval County. At Jacksonville Beach, the Beaches Hospital located at 1430 16th Avenue South, which has a disaster plan, is situated approximately 20 feet above mean sea level and thus would be affected by the storm surge coming from a Category 4 landfalling hurricane. The Hospitality Care Center of Jacksonville Beach, located at 1504 Seabreeze Avenue, has an agreement to move clients to three nursing homes located inland. They are Americana Health Care Center, Turtle Creek Health Care Center, and Jacksonville Convalescent Center. The Hospitality Care Center would be affected by the storm surge coming from a Category 3 landfalling hurricane.

St. Johns County. The City of St. Augustine has one hospital and three nursing homes which would be affected by the storm surge emanating from a hurricane. Flagler Hospital located at 159 Marine Street and St. Johns County Senior Citizen's Home located at 169 Marine Street are approximately five feet above mean sea level. Although across the Matanzas River from Anastasia Island, the side effect from the storm surge of a Category 1 hurricane entering St. Augustine Inlet would impact these facilities. Flagler Hospital's administrative personnel plan to resort to vertical evacuation as the building has three levels. The second level is at least 20 feet above mean sea level. Administrative personnel of the Senior Citizens Home plan to move their clients to the second floor of Flagler Hospital.

Flagler Hospital will accommodate the clients of yet another nursing home, the Buckingham Smith Memorial Home located at 169 Central Avenue. This home, approximately five feet above mean sea level, would be affected by the storm surge coming from a Category 3 hurricane. Silmer Nursing Home located at 189 San Marco Avenue would be affected by the storm surge coming from a Category 2 hurricane. This home is approximately eight feet above mean sea level. Gilmer Nursing Home will move clients (by existing agreement) to both hospitals in the City of St. Augustine, Flagler Hospital and St. Augustine General. Gilmer's administrators also will have their clients moved to the St. Augustine Geriatric Center and to the Ramada Inn (in the City of St. Augustine), to Putnam Memorial Hospital in Palatka, and to Lake Shore Nursing Home in Crescent City.

RECOMMENDATION

It is recommended that the special committee in St. Johns County consisting of administrative personnel from the School Board and the local chapter of American Red Cross plus the Civil Defense Director continue their effort to seek and designnate additional public shelter space. Members of that committee are Messrs. Steve Hand, Wally Baughn, John Atkins, and Douglas Stewart of the St. Johns County School Board; Mr. Bill Tyler, Mrs. Stuart Crouch, and Ms. Irene Pace of the American Red Cross; and Mr. Gary Rodehorst, St. Johns County Civil Defense Director.

SUMMARY OF RECOMMENDATIONS

A. It is recommended that local governments:

1. Take measures as necessary to preserve existing primary dunes, to prohibit excavation on other development on the landward toe of any primary dune, to prohibit breaches of primary dunes, and to fill and stabilize existing breaches of primary dunes with vegetation. See page 28.

2. Stipulate in the approval of developments located within a hurricane hazard (vulnerable) area that all title transfers to property shall be accompanied by a hazard disclosure statement that the property in the particular development is within a hurricane hazard area in which property is subject to damage and residents may be subject to an evacuation order in the event of a hurricane landfalling within 50 miles of the development. See page 28.

B. It is recommended that the special committee in St. Johns County consisting of administrative personnel from the School Board and the local chapter of American Red Cross plus the Civil Defense Director continue their effort to seek and designate additional public shelter space. Members of that committee are Messrs. Steve Hand, Wally Baughn, John Atkins, and Douglas Stewart of the St. Johns County School Board; Mr. Bill Tyler, Mrs. Stuart Crouch, and Ms. Irene Pace of the American Red Cross; and Mr. Gary Rodehorst, the St. Johns County Civil Defense Director. See page 106.

APPENDIX A

Excerpts taken from "The Formation of Tidal Inlets in Barrier Island Chains"

APPENDIX A

Excerpts taken from "The Formation of Tidal Inlets In Barrier Island Chains," abstract produced by Steve Hughes, Graduate Assistant, University of Florida.

B. INLET FORMATION BY ATTACK FROM THE SEAWARD SIDE: Large storms are usually accompanied by a rise in sea level elevation, termed the storm surge, which is generated by the onshore wind shear stress over the water surface, resulting in a "piling up" of water along the coastline. These storm surges, along with their huge wind-generated waves, are responsible for major flooding and erosion of the coastal areas.

At times these waves are capable of overtopping the frontal dunes, which are usually the highest feature on the barrier island. Once the water associated with these waves has passed over the highest point of the barrier, then it must continue to flow down the back face of the island and into the lagoon, by reason of both the kinetic energy involved in the water's forward momentum and the potential energy due to its height above still-water level in the lagoon. If the flow can be channeled and if frictional losses are small, the available energy may be sufficient to cut a channel by transporting the barrier island sediments and depositing them in the lagoon. The uneven topography which channels the flow can come about by natural processes, such as the initial building of the barrier island or wind-scouring of dunes; or they may arise by human endeavors, such as cuts made through the dunes to provide access to the beach. Lack of vegetation in this erosional channel certainly helps to reduce the initial frictional losses. The process is further aided by the fact that the still-water level in the lagoon is usually lower than the surge level on the ocean side, due to the time-lag involved in transferring the excess storm surge water into the lagoon through existing inlets. This allows additional erosion to occur, after the channel has been cut down to the surge level, by virtue of both forward wave momentum and by the head difference between ocean and bay.

There are three important determining factors upon which the formation of the new inlet is dependent. These are: the slope of the back side of the barrier island, the width of the barrier island, and the depth of the lagoon adjacent to the barrier island. If the slope is small, or the island is wide, or a combination of these two, then it is likely that the water will not obtain sufficient velocity to erode deeply into the channel due to both frictional losses and percolation of the water into the barrier island. The sediment that is transported will be deposited in the form of an "overwash fan" which further reduces the slope and increases the distance over which the water must travel. Alternately, a shallow lagoon adjacent to the barrier will cause a rapid build-up of the overwash fan which then forms into a series of distributaries and effectively spreads out the flow, lessening the probability of erosion to a depth sufficient to cut below still-water level.

From the above discussion it can be concluded that tidal inlets formed by overtopping from the ocean side will most likely occur where the following conditions are met:

1. The barrier is narrow, and the back slope of the island is steep, which keeps the frictional losses to a minimum by decreasing the distance the water must travel. This and the sleep slope allows higher water velocities which in turn move more sediment.

2. The initial barrier topography is such that the overwash is channeled, and to a lesser extent, the vegetation is sparse.

3. The adjacent lagoon is sufficiently deep to cause deposition of that eroded material into an overwash fan without the formation of a series of distributaries which spread out the flow, or without a significant decrease of the slope.

An example of an inlet formation by attack from the seaward side was documented by El-Ashry and Wanless (1965), and occurred on the North Carolina coast just to the north of Cape Hatteras. Historical records are full of similar examples of storm-related inlet openings.

C. INLET FORMATION BY ATTACK FROM THE LAGOON SITE: Pierce also theorized that inlets could also be formed during a storm by water attack from the lagoon side of a barrier island. Noting that tropical storms are often characterized by a sudden reversal of wind direction from onshore to offshore, he felt that sufficient momentum could be imparted to the lagoonal water to cause a breakthrough of the barrier island.

During onshore winds the water is "piled up" on the ocean side; and if the lagoon is large enough, the lagoonal water will also "pile up" along the coast of the mainland, resulting in an exceptionally low water level to the lee of the barrier island. As before, there is a lag time necessary for the existing inlets to allow the ocean surge to pass.

After passage of the center of the storm, a sometimes rapid wind shift to the offshore direction can take place which lowers the storm surge level on the ocean side of the barrier and leaves the water, which was piled up on the mainland, unsupported. This unsupported mass of water will rush across the lagoon under the force of gravity, aided by the offshore wind, and slam against the landward side of the barrier island.

In a large lagoon this surge can contain a huge amount of water which is capable of overtopping the island in low spots. If there is a topographical feature to channel the water, then erosion can occur in the same fashion as described earlier. This is illustrated in Figure 7b. Pierce points out that tidal channels and creeks are nearly always present in the marshes and barrier flats, and are sometimes connected to low spots in the dune fields. These provide a limited number of access points for the huge volume of water, and can channel the flow until the foredunes are overtopped and gravity takes over. If there are no channels present, then little damage will be done by this surging lagoon water.

Once the water has reached the top of the foredune it rushes down the relatively steep foreshore, sweeping eroded sediment with it.

Since the ocean level is now lower than normal, this overtopping can erode a channel below the usual sea level, forming a new tidal inlet. Sediment deposited at the end of this channel is reworked by the waves and hence, no overwash fan is formed to hinder the flow.

The main criteria for inlet formation by attack from the lagoon side are:

1. A large, fairly wide lagoon which experiences substantial wave setup during high winds, with sufficient depth to minimize frictional losses.

2. A sudden wind reversal from the onshore direction to the offshore direction.

3. Tidal creeks and channels must be present on the landward side of the barrier island to the channel and concentrate the flow over the dune field.

APPENDIX B

SPLASH MODEL

APPENDIX B

SPLASH MODEL

The SPLASH model is a mathematical model which utilizes a linearized form of the equations of motion. The equations have been converted to finite amplitude form and are applied to a grid system. Information required on this grid before computations can proceed are the hurricane data mentioned on pages 9 and 10 as well as the values of the depths of the continental shelf. The representation of the depths is termed the bathemetry and has already been completed for all of the U. S. coastline. From previous studies, it has been shown that the shallower the water on the continental shelf, the higher the storm-surge will be. As the water is shallower at Jacksonville Beach compared to Daytona Beach, a hurricane with the same speed, direction, delta-p, and RMW will produce a larger peak surge value at Jacksonville Beach.

The grid points along the shoreline are considered the shoreward boundary of the model and allow no water to move inland (i.e. a vertical wall). If the barrier islands are high enough, then this boundary condition is an excellent one. If the barrier islands are low, inland flooding may occur and the location of the highest surge values may be inland away from the beach front. However, the SPLASH model assumes a vertical wall at the shoreline. Therefore, careful interpretation of the results is required in this case.

APPENDIX C

SURVEY QUESTIONNAIRE FORM

BEHAVIORAL SURVEY FOR THE
NORTHEAST FLORIDA HURRICANE EVACUATION PLAN

Resident's Address:

Telephone Number:

Call No / Attempt Detail	1	2	3	4	5
Date	/	/	/	/	/
Time	.m.	.m.	.m.	.m.	.m.
Result					
Person, Time & Date for call-back	_______________ (name)			_______ (time) .m.	
			/ /83		

INTERVIEWER: IF INITIAL RESPONDENT IS APPARENTLY AN ADULT AND, THEREFORE, POSSIBLY THE DESIRED RESPONDENT (HEAD OF HOUSEHOLD OR DECISION-MAKER CONCERNING WHAT TO DO BEFORE A HURRICANE) CONTINUE; OTHERWISE, MAKE AN APPOINTMENT TO CALL BACK AT A TIME THAT THE RESPONDENT CAN BE REACHED.

INTRODUCTION: "Hello, my name is _________ and I am working on the Hurricane Plan being prepared by the Northeast Florida Regional Planning Council. May I speak to someone who would help decide what to do if a hurricane threatened? (INTERVIEWER, IF PERSON WITH WHOM YOU ARE SPEAKING IS A DESIRED RESPONDENT, CONTINUE WITH ....) "Your answers to a few brief questions will be greatly appreciated."

1. Do you live in a:
   a. Single-family home ( )
   b. Apartment building ( )
   c. Condominium building ( )
   d. Mobile home ( )
   e. Other _______________ (specify) ( )

2. For this next question, please assume that everyone is home and you were ordered by a governmental authority to evacuate. How soon could you be ready and would you leave? (PAUSE: IF NO RESPONSE, ASK)
   a. Immediately ( )
   b. Certain number of hours ( ) - number
   c. Never ( )

3. How many people live in your home including yourself? ________ number

4. Do you and members of your household live in the area during the months of June through November? Yes ( ) No ( )

5. Do you and members of your household live in the area also during the months of December through May? Yes ( ) No ( )

6. How many vehicles are there in your household? ________ number
(IF NONE, SKIP TO 6b)

6a. (IF THERE ARE VEHICLES, ASK) How many vehicles would you use during an evacuation?
(SKIP TO QUESTION 7) ________ number

6b. (IF "NONE" IN QUESTION 6) Would you need transportation such as a bus or a taxi?
Yes ( ) No ( )

7. Is there anybody who could not be evacuated without help from outside your home?
Yes ( ) No ( )

8. After leaving, where would you go? (PAUSE, IF NO RESPONSE, ASK)

a. To a designated Red Cross Shelter ( )
b. To a friend or relative ( )
c. And in what county would that be please?

____
(Take a City Name, if Necessary)

d. To a hotel or motel (IF "YES" ASK) ( )
e. And in what county would that be please?

____
(Take a City Name, if Necessary)

f. Don't know (DO NOT READ "DON'T KNOW") ( )

9. What route would you take to get to a shelter, friend or relative, or motel, i.e., what major highway or street? ________________________________

____

10. Have you ever experienced a direct hurricane strike? Yes ( ) No ( )
If "yes", where was that, when, and name the hurricane.

____

____

11. Mr./Mrs.________________, into which age group do you belong?

35 & Under	35-49	50-64	65 & Over
( )	( )	( )	( )